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THE CLASSICAL QUESTION IN GERMANY.

By EDMUND J. JAMES, Ph. D.,

PROFESSOR OF FINANCE AND ADMINISTRATION IN THE UNIVERSITY OF PENNSYLVANIA.

THE struggle between the adherents of the old classical curriculum and the representatives of modern culture has nowhere been carried on with more bitterness than in Germany. In no other land have the respective antagonists shown more narrowness and bigotry, or been less inclined to allow their opponents the possession of common sense or pure motives.

The representatives of the classics, intrenched behind a strong wall of tradition and usage, were from the first in the enjoyment of all the honors and privileges. They were supported by the mighty power of a public sentiment which had been begotten at a time when the classics and mathematics formed the only subjects worthy of serious study, and had been nourished by a long line of illustrious men whose only school-education had been a training in Latin, Greek, and geometry. They were upheld by the powerful force of a government which made the acquisition of such an education the condition of all its favors. They looked down, therefore, naturally enough, with a certain contempt and loathing upon those rude materialists who insisted that there was something in the modern world worthy of serious study. The other party, on the contrary, driven to extremes by the bigotry and obstinacy of their opponents, were compelled to make war to the death, by denying all virtue of any sort to a classical training. They insisted on purely modern subjects as opposed to classics, on a multiplicity of branches in preference to a few, on technical education for particular callings instead of a liberal training for good living.

But in the course of events we find both parties in that country receding from their extreme positions and gradually approaching each

other. We find the "classicists" agreeing that the study of modern languages may also be made valuable; that modern literature is adorned with names which rival in luster the greatest of the Greek or Roman. They give up slowly more and more of that valuable time formerly spent in conning Greek and Latin grammars, or in learning to write Greek and Latin verses, or to talk a jargon which they dignify by the name of classical Latin, to the study of French, Italian, Spanish, German, and English. They allow the elements of the natural sciences, one after another, to creep in, and even grant some hours a week to modern history. They still devote the most of their attention, however, to Latin and Greek, and justify their course by the claim that the shortest road to modern literature is through Athens and Rome; that modern languages are so intimately connected with the classics that, after mastering the latter, the acquisition of French, English, Italian, and Spanish, is a matter for leisure hours, a mere after-dinner amusement; that the nomenclature of the modern sciences is so largely Greek that time would be saved in learning them by first mastering Homer, Xenophon, and Plato; that modern history is only the second chapter of the world's history, and can be rightly understood only after learning what goes before.

Their most thoughtful opponents have also given up many of the claims advanced by their prototypes. They allow that there is a vast difference between knowledge and power; that a mass of undigested facts in the memory is as depressing for the mind as a mass of undigested food in the stomach is for the brain. They, or at least the most advanced among them, allow that the old humanists followed sound pedagogical principles in selecting but few subjects, and in lingering over them long enough to secure that mental power and grasp which come from the detailed and long-continued study of any great branch of human knowledge. They grant that the secondary schools should give a liberal education, in the sense of an education which shall prepare the students, not for the particular calling which they may afterward take up, but for right and intelligent living, in any sphere to which circumstances may call them. They maintain, however, that for the purposes of such an education modern subjects are as good as or better than ancient; that French and English, if properly taught, can afford, so far as is desirable, the same kind of mental discipline as that obtained from Latin and Greek; that modern literature embraces classics as worthy of detailed and continuous study as ancient literature; that the proper study of the modern sciences develops certain faculties with a completeness of which no other instrument is capable; that modern history offers subjects as worthy of labor, as fruitful in results, as anything which ancient times can afford.

The objective points of the contest have also changed in the course of time. The old philanthropinists demanded the total abolition of all

classical study as a waste of time. The classical party of that period resisted the introduction of any studies but Latin, Greek, and mathematics. The "modernists" of to-day demand the abolition of Greek as a required study in a liberal course. Many of them, indeed, would like to send Latin the same road. The modern "classicists" are on the defensive, and constantly grant more concessions, or see them wrested from them.

This discussion, which in one form or another has appeared in every civilized nation, has been everywhere marked by bitterness and prejudice, and has resulted in a slowly-growing victory for modern culture. The question has attracted renewed and wide attention in this country of late, owing to Mr. Charles Francis Adams's attack upon the requisition of Greek as a part of the course in Harvard College. The old weapons on both sides have been again brought out and burnished, and made to do valiant service in the good cause. The result of the criticism and counter-criticism has been to demonstrate pretty clearly that, however we may feel about it, the fact is, that the cause of the "modernists" is gaining ground. President Porter, in a rejoinder to Mr. Adams, in the "Princeton Review" for September last, remarks, in substance, that the proposition to drop Greek from the list of required studies was somewhat "hesitatingly urged many years ago by the adventurous and sanguine President of Harvard College." If the writer is not greatly mistaken, President Eliot did not only urge it years ago, but has vigorously and persistently urged it ever since, and it is probably only a question of time when his policy will be adopted, whether urged by him or by some one else.

The discussion as to the relative merits of the classics and other subjects, as constituents of a liberal course of study, has always been marked by a great deference to authority. The assertions of eminent men, as to the advantage or disadvantage to them of the classical course which they pursued while young, always play a prominent part. The testimony of eminent educators, as to their observation of the effect that a study of the classics seemed to have on the minds and hearts of their pupils, is quoted and requoted. The tradition and usages of hundreds of years are strongly appealed to in order to show the superiority of the one system over the other.

The present discussion in our American press has been no exception to the rule. But, in addition to the regular authorities which are quoted on all occasions, a new witness has been appealed to in this controversy, whose testimony on the question is regarded by many as decisive and final. This is the experience of the Germans, embodied in what is known as the "Berlin Report," and which has been widely urged as an authoritative answer to Mr. Adams's argument. It seems to be supposed that this thorough-going people have entered into the subject experimentally and on an extensive scale, with a view of settling it effectually. They have made, it is asserted, a fair trial of

these two systems of education, and, having weighed both in the balance, they have found the modern system wanting to such a degree that they have concluded to discard it forever. There seems to be wide-spread misconception about this German experiment, and the conclusions drawn from it are so unwarrantable that a review of the main features of the case may be useful in correcting erroneous impressions.

As is well known, there are two classes of schools in Germany which prepare boys for the university—the *Gymnasien* (gymnasia) and the *Realschulen* (real schools). The former are the classical schools, whose curriculum consists in the main of Latin, Greek, and mathematics, and graduation from which confers the right to enter any department of the university. The real schools are institutions whose course of study embraces less Latin than the former, and no Greek, the place of the latter being represented partly by more of the modern languages and partly by natural science. The gymnasia are old schools, being the legitimate successors of the schools which dated from the revival of letters. The real schools are products of the modern spirit, and, although dating from about 1740, they did not acquire a recognized standing until late in this century. The earliest of these schools were the answer to the demand for "practical" education in the narrowest sense of that term. It was not until 1859 that the Government of Prussia fully recognized them. In that year, the schools passing under that name were classified, according to length of course, into first, second, and third class. The course of the first class was made of the same length as that of the gymnasium—that of the other classes was shorter. From that year the friends of the real schools demanded that graduates of schools of the first class should be admitted to the universities. Their claims excited at first only a smile of derision, but so vigorously did they push matters that the Government, in 1869, was persuaded to take the first move in the case by asking the faculties of the various Prussian universities for their opinions on the subject. This called out a series of reports which were very strong against admission. It is curious that in this series of reports language was used from which we might infer that the universities had already tried the experiment; as when it is asserted in one report that the gymnasium students soon overtake real-school students even in natural science—that at a time when real-school graduates were not admitted to the universities. The Government decided, however, to admit the real-school students to certain branches, which it did by the order of December 7, 1870.

Until 1871, then, the graduates of real schools were not admitted to any department of the universities in Prussia as candidates for a degree. In that year they were allowed to matriculate in the university for the study of modern languages, mathematics, and natural science. After an experience of about eight years, on the 18th of De-

cember, 1879, Professor Droysen, of the University of Berlin, moved that the faculty of that institution request the Government to reconsider its policy in regard to the admission of real-school students to the philosophical faculty. After some discussion, Professor Hübner, the dean of the faculty, was requested to ask the various professors for statements of their experience with the two classes of students. These statements were laid before the faculty, and the most important being incorporated in the form of a report, were sent in, March, 1880, to the Government, with the petition that the latter would reconsider the whole matter—the real object of the report being to move the Government to rescind the order of December 7, 1870. These were not the first statements on the question, for the Minister of Public Instruction had already, a short time before, made inquiries of many leading professors in the various universities as to their experience in the matter since 1871. The most of them held views similar to those of the Berlin professors. The set of statements, with the petition above referred to, constitutes the "Berlin Report," and, on account of its formal and authoritative character, has excited world-wide attention and discussion.

These reports are now quoted by many as a final settlement of the much-disputed question between the "classicists" and the "modernists," and by many more as expressing the judgment of educated Germany, at least, on the subject. Thus, President Porter, in the article above mentioned says: "The question of the superiority of a classical to a modern training has of late been subjected to a practical trial on an extensive scale, by a comparison of the results of the gymnasial curriculum and that of the *Realschule*, as a preparation for a university course and indirectly for civil administration. In most of the German states—in Prussia pre-eminently—an attendance upon the university course, with a certificate of fidelity and a succession of satisfactory examinations, had been the essential prerequisites to many of the most desirable official positions in civil life. To admission to all the privileges of the university an attendance upon the gymnasium with the classical curriculum was an essential prerequisite, carrying with it the consequence that to all the higher posts of civil life a course of classical study, including Greek and Latin, had till recently been a *conditio sine qua non*. The *Realschulen*, which gave a shorter and a more scientific and popular course, in which Greek was not included, and the Latin was scanty, furnish an example of a modernist education. It was very natural that this condition of things should be felt to be inequitable by the teachers and pupils of these schools, and that an earnest movement should be made to set it aside. In several of the states it was successful. In Prussia, against strong conviction to the contrary, it was allowed for a term of years by way of experiment, that the 'modernists' (the *Abiturienten der Realschulen*) should enter the university and enjoy all its privileges. When this

term had expired, elaborate reports were called for from the leading instructors in all the universities, of their judgment as to the proved capacity and success of the students who had attended upon their classes, from each of the two preparatory institutions with their separate curricula. With but few exceptions the reports were decidedly in favor of the classical curriculum as giving a better training even to the students of the mathematical and physical sciences."

We wish to call attention here to the fact that President Porter's first sentence, though evidently without any intention on his part, is misleading. He says that "the question of the superiority of a classical to a modern training has of late been subjected to a practical trial." Not at all; but simply the question of the relative superiority of the graduates of the German gymnasia and real schools, as they exist to-day in Germany, as indeed President Porter himself states in the next to the last sentence quoted above. This last is a very different question, indeed, from the former. The one is, so to speak, concrete; the other, abstract. The professors were not asked for their opinions as to whether a classical is better than a modern training, but is the gymnasiast, as you know him from the existing schools, better fitted for your work than the real scholar who during the last eight years has attended the university?

If it should appear upon examination that the curricula of the real schools are not what is demanded by the most thoughtful "modernists," that the teachers are not, as a class, equal to those in the gymnasia, that the pupils are, as a whole, inferior in natural ability, that the real schools are not fostered by the Government to the same extent as the classical schools, it will be evident to every one that the significance of the Berlin report for the real question at issue—viz., classics at their best *vs.* modern subjects at their best on an equal footing in every respect—becomes very slight.

As appears from what we have said above, President Porter is mistaken when he says that the graduates of the real schools were admitted to all the privileges of the university. They were only admitted to certain branches in one faculty, viz., the philosophical faculty. They were not, however, admitted for a definite number of years, as President Porter states, but for an indefinite period. The ministerial regulation admitting them says nothing whatever of any number of years for which it is valid. It holds good until supplanted by one prohibiting the admission of real-school students, and there is no sign that such a regulation will ever be made.

To begin with, then, all this quoting of the Berlin and similar reports in favor of retaining Greek as a required study in our liberal curricula is aside from the point, since that report was made on a very different subject. The attempt to apply conclusions on concrete questions in one country to concrete questions in another is at all times a misleading and often a dangerous procedure.

Now as to the report itself, it may fairly be objected by the real-school men that the real schools have not had a fair trial, that the period of probation has been so brief that any report made now, whether favorable or unfavorable, must be regarded as premature and at best merely provisional. The real schools of the first class are not yet twenty-five years old. The regulation admitting their graduates to partial university privileges bears date, as said above, of December 7, 1870. In less than ten years they were expected to win a place by the side of their rivals, which even their bitter opponents (for the professors who made the reports were all graduates of the gymnasia) should acknowledge to be an equal one, and if they should not succeed in doing this they were to be condemned as unable to fit boys properly for the university. Further, they were expected to do this with almost no aid from the Government, while their rivals were largely supported by contributions from the state. How just this complaint is may be seen from the reports of government aid accorded in Prussia to these two classes of schools. In the year 1869 the Government contributed 714,148 thalers out of a total expenditure of 2,851,253 thalers for gymnasia; and in 1874, 1,319,990 thalers out of a total of 4,385,940 thalers for the same purpose. In the former year the real schools of the first class cost 666,368 thalers, of which the Government contributed 15,558 thalers. In the latter year the respective sums stood 1,251,921 and 97,421 thalers. It thus appears that the Government paid in 1869 nearly forty-six times as much toward supporting gymnasia as it did toward supporting real schools, and in 1874 over thirteen times as much. In 1869 it paid over twenty-five per cent of the total expense of all gymnasia, and less than three per cent of that of the real schools; in 1874 the respective rates stood over thirty per cent and less than eight per cent. It will thus be seen that the Government has proceeded on the plan of allowing the real schools to pay their own way. The wonder is, that they have such good results to show for their work under such circumstances. It should be also considered in this connection that the proper equipment of a real school, with first-class apparatus, etc., costs much more than that of a gymnasium. Another fact should be borne in mind, that owing to this lack of support the number of such schools is much smaller than that of the gymnasia, and they have consequently not had so extensive a field to draw from as the latter. Another important point must be mentioned in this connection. Up to 1871 the graduates of the real school passed immediately into active life instead of attending a higher institution of learning. The matter and methods of the school had, therefore, exclusive reference to that fact, and under the new system they must have time to modify and adapt themselves to the altered circumstances. Any practical teacher will appreciate the importance of this consideration. These are some of the objections which the defenders of the real schools have to urge against any unfavorable report made at this stage of the work. Against

this particular series of reports, made in the manner in which they were, they have still more serious objections, which we shall notice later.

Turning aside now to another phase of the subject, let us see whether any influences have been at work which tend to give the gymnasia a better class of material to work with. If the boys who enter the gymnasia are decidedly superior in ability to those entering the real schools, we shall have a partial explanation of the better results achieved by the former.

The first point to be mentioned in this connection is that the traditions of Germany are classical. For decades and decades nearly every prominent man in law, medicine, theology, teaching, and (so far as nobility has not been accepted as a substitute for education) in the civil and military service of the country, has enjoyed the benefits of a classical education, if for no other reasons, simply because he was obliged to "enjoy" them as a condition of entering these careers. We all know how easily we associate two things which we always see together, in the relation of cause and effect. And so this eminence and culture which, owing largely to the artificial pressure we have mentioned, have for years and years in Germany been found in connection with a more or less complete knowledge of Latin and Greek, have come to be associated with the latter as effect from a cause. The sign has come to be largely accepted in place of the thing signified. It can not have escaped the observation of any reflective person who has ever lived in Germany, that there is a very wide social chasm in that country between the so-called liberally educated (*die Studirten*) and those who have not pursued such courses. There is, so to speak, an educational hierarchy, and the only path to it lies through the gymnasium. As in all hierarchies, so in this, there is an immense amount of Pharisaism, a touch-me-not and a come-not-near-with-unholy-hands kind of spirit which looks down on everything not of its type as something infinitely lower. The *Studirter* looks down, not only on the merchant or the artisan, but also upon the *Volksschullehrer* (common-school teacher) with a calm sense of superiority and a provoking self-conceit—no matter how successful the career of the latter may have been. A small professor in a small university, of small ability and still less success, commiserates the most successful common-school teacher because he has not studied Latin and Greek; and we must add that the latter envies the former, taking the sign (Latin and Greek) for the thing signified (culture). No *Studirter* thinks of seriously discussing any question with a *Non-studirter*, but disposes of all difficult objections by the crushing answer that his opponent is an *ungebildeter Mensch*.

The artisan or merchant sees that no amount of culture derived from the study of modern subjects, or in the pursuit of his calling, or from the vigorous contact with active life, can secure for him a social recognition or equality with the *Gelehrter;* the common-school teacher sees

that no career of public service in his sphere, however useful or successful, can secure entrance for him into that charmed circle of the *Gelehrtenthum*, and silently resolves that his boy must have a different chance from that which he has had. Of the force which this traditional influence exerts no one can form an adequate idea who has not had the opportunity of associating intimately with the various classes of the people; for, although a similar spirit may be met in America, it is of such small influence as hardly to be discernible.

A classical education has, then, come to be the proper thing in Germany for every aspiring man. It is a stamp of gentility, an absolute essential to high social position and influence. Every parent desires to give it to his boy, if for no other reason, simply on account of this different social position which it confers upon him. To give him this education he must send him to the gymnasium.

But there is another and still more powerful influence at work to secure the attendance at the classical schools. We have already corrected President Porter's statement that the graduates of the real schools are admitted to all the privileges of the university. They are not allowed to enter the law, medical, or theological faculties, and their privileges in the philosophical faculty are practically limited to the study of natural science, mathematics, and modern languages. That is to say, if a father wishes to keep open to his son when he becomes twenty years of age the choice of the learned professions, and the possibility of obtaining any of the higher positions of the civil service, he must put him through the gymnasium in the first place.

Of course, under such circumstances, all professional men desire their boys to follow one of the learned professions, and send them consequently to a gymnasium. During an extensive tour in Germany last summer, the writer had the opportunity of meeting a large number of university and other professional men. In answer to the question which was quite regularly asked, "What school do your boys attend?" they replied, almost without exception: "The gymnasium, of course; we send them to the real school only when they are too stupid or too lazy to keep up in the gymnasium." Thus the educated and intelligent classes send their boys, who, to some extent at least, have inherited their intelligence and ability, to the gymnasium. Those members of the mercantile or artisan class, who have bright boys from whom they hope much, strain every nerve to support them at the school which forms the sole avenue to all government honors and social position.

Do we not find here the explanation we are seeking? Is not this the secret why the boys who graduate from the gymnasium are as a class superior to those who finish a real-school course? They are the brighter boys of the community; they are, as a rule, of educated blood, from homes where education and refinement prevail, and life

within which is of itself an education, where they find wise and discriminating assistance in their studies, and encouragement and incitement to effort.

But the case is not by any means fully stated. The gymnasium not only gets better material to work upon than its rival, but it has also a superior corps of teachers. The writer was told by a gentleman who was a graduate of a real school, and who had been a teacher in one for some time, but had afterward made up the Greek and Latin of a gymnasium course in order to qualify himself for teaching in a gymnasium, that no teacher of ability and enterprise would remain in a real school any longer than he was obliged to remain there. "There is no career in that line of work," said he, "and only blockheads and lazy hides (*Dummköpfe und Faulpelze*) stay in it." Of course, that was a great exaggeration, and yet it contained an element of truth, viz., that a process of selection is going on between these two schools, not only in regard to pupils, but also in regard to teachers, and the gymnasium has its pick of both.

The reason is not far to seek. It is to be found in the higher social position which tradition assigns to the office of gymnasial teacher, and the better career which the Government opens to it. How idle, in the face of all these facts, is the assertion that the Berlin report has settled the question between the real school and the gymnasium, or that it is of paramount significance in the deeper question of classical against modern training!

To get a fair idea of the significance of this report, let one imagine the state of things which would exist in this country if the law of the land had for generations permitted no one to practice law or medicine, or enter the ministry or the civil service, or become a teacher in our higher schools and colleges, who had not first completed the classical course in an average college, and then attended a professional school for three years. Suppose that, after such a law had been enforced for a century, a proposition were made to allow such scientific schools as could spring up under those circumstances to present their students for certain subordinate places in the civil service and in the academic career. Can there be any doubt that the adherents of the classical culture would point with pride to the fact that every eminent professional man for several generations had been the graduates of classical schools, and would make that a reason, as they do now in Germany, for refusing to admit any man with a different education to the practice of those professions? Would they not dwell on the great danger to the national civilization which would arise from the fact that an element of discord would be introduced into the culture of the people by educating the young along two widely different lines? *

* This argument plays a large part in the German defense of a single school and a single course in preparation for all higher professions. "Our education," says one, "is homogeneous. Let the real school carry its point, and a hopeless and fatal element of

Would not our professors complain, as does one in Berlin, that they could not make so many references to Greece and Rome in their lectures, since some of their hearers would not understand them?

Let us suppose further that the above proposition should be accepted, and that after eight years a committee of the opponents of the measure should be called upon to express their opinions as to the results of the experiment. Could their report be considered as settling anything between the two opposing parties—the defenders and opponents of classical culture? Could the statement of these witnesses, that the students who, under such conditions, came from the scientific schools were not fully equal to those coming from the classicals chools, be regarded as forever disposing of the claims of modern culture? The answer to this question can hardly be doubtful. And yet those who quote the Berlin report, as settling this much-vexed question, must maintain that such a report as the imaginary one above described would be satisfactory and conclusive.

We have thus far proceeded upon the assumption that the Berlin and similar reports were prepared by unprejudiced men, after a careful and detailed examination of the records made by the graduates of these two schools, and uninfluenced by extraneous considerations. We are compelled to believe, however, after a somewhat detailed investigation, that no one of these assumptions is true.

The men who were asked for their opinions on this subject were almost, if not absolutely, without exception graduates of the gymnasia. That lay, of course, in the nature of the case. Real-school graduates could not enter the universities until the spring of 1871. Allowing four years for the average length of time spent in the universities, the first real-school men were graduated in 1875, and in 1879 the first of these reports was prepared. As the candidates for admission to the university faculty must study one year more before entering the lowest grade of academic positions, and as promotions are very slow in Prussia, it would be a very rare thing for a graduate of 1875 to have reached a professorial chair by 1879. Those who made these reports were therefore men from rival schools, men imbued with prejudice in favor of the preparatory curriculum which they themselves had completed, men entirely under the sway of the traditional feeling in regard to the classics, and, of course, inclined to look with disfavor upon real-school men as representing a movement which questions the worth of classical culture. It is a well-known fact that there is usually a strong tendency for a man to attribute his general success in life to the particular things which he did, or left undone, and that it is an easy thing to regard an incidental as an essential. The worthy German professors are no exception to the rule. Many of them were so strongly convinced of the superiority of classical to modern training

antagonism will be introduced into our national life, and our higher scholarship, that fairest flower of our civilization, will perish from the earth!"

that they went out of their way to declare that a study of Latin and Greek is absolutely essential to high excellence in any department of intellectual effort!

All these reports, both those of 1869 and those of later years, so far as they were made by the faculties, were as a rule drafted by volunteers in the faculty, and some rabidly classical man generally offered to do the work. When his report was laid before the faculty, many voted for it, or refrained from voting against it, for the simple reason that they did not have time to offer such modifications as they would like to have seen made in the language or matter of the report. Thus, the writer was told by one professor in a university which sent in a very strong report in favor of the gymnasiasts as against the real-school graduates: "Professor So-and-so" (mentioning his name—one well known in Germany) "drew up our report. He is perfectly crazy on the subject, but there was no one else to do it, and after he submitted it we did not want to do such an ungracious thing as reject a service which nobody else would undertake. I voted for his report, though I should have been glad to have a much more moderate and judicial report than the one we sent in." It thus appears that these reports were prepared by men who were not only graduates of the gymnasium, but who were also, in some cases at least, regarded by their own friends as extremists. Add to this the fact that there were no representatives of the real schools in the reporting board who might have called attention to exaggerations or misstatements, whether intentional or unintentional, and it is pretty clear that these reports can not be called judicial, either in their form or spirit, but partake largely of the character of advocates' pleas.

It would be fair to suppose, however, that these men would at least examine the facts in the case as to how these real-school graduates turned out in after-life, before making a report on their comparative ability. But even this supposition turns out to be an unfounded one. As is well known, there is no general system of recitation and record-keeping in German universities, such as we have in our American colleges. The professor has, therefore, as a rule, no means of judging of a student's attainments. There are no examinations except the final one for a doctor's degree. The only institution bearing a resemblance to our recitation is the *Seminar*, a voluntary organization which many students never enter, and which varies greatly in character, according to the temperament of the professor in charge or to the subject-matter discussed. Being at times a society for the training of the members in the power of independent investigation and research, it becomes often a mere "quiz," or indeed but little more than a two hours' lecture on the part of the leader. With the exception of those students who enter the *Seminar*, the professor has no means of judging of the ability or training of the university students. The only test, therefore, is the record of such students in the final

university examinations for a degree, which comparatively few students ever attempt, their record in the state examinations which nearly all try, and the final and decisive test of practical life and its demands.

Now, it is a pretty plain fact that the professors who made these reports did not take the trouble to investigate the results of these various tests, since it was reserved for a director of a real school to collect the first reliable and comprehensive statistics on the subject, and that *after these reports were prepared.* The data were furnished by the reports of the universities as to the number of degrees granted to real-school graduates, by the reports of government examiners as to standing attained in the public examinations of such students, and, finally, by the reports from the present positions and sphere of labor of all real-school graduates who had taken degrees from the universities, or who had passed into the ranks of teachers without trying the university examination. We have not room to introduce the statistics here. Suffice it to say that they make a very good showing for real-school graduates. The point that interests us most in this immediate connection is, that these facts were not ascertained or considered by the university professors who reported on this subject.

The same gentleman who collected these statistics tells a well-authenticated story of Professor Hanstein, of the University of Bonn, which very well illustrates the fairness, deliberation, and investigation which preceded and accompanied these reports. Upon receiving the notice asking for his written opinion, he remarked to his assistant: "So we have to commit ourselves in writing again, do we? Of course, the gymnasia students are superior." "But, Herr Professor," objected his assistant, "Mr. X——, who recently took his degree in natural science, passed *summa cum laude*, and he is a real-school graduate." "Yes; well, he's an exception." "And Herr Dr. ——, the *Privatdocent* here in Bonn, is also from a real school." "He's an exception too," answered Hanstein. "And a few weeks ago," continued his assistant, "one of our real-school students passed his teacher's examination in chemistry and natural history No. 1." "Exceptions—all exceptions!" replied the professor. "Yes, but, Herr Professor, there are only seven or eight of us real-school men altogether here in Bonn." "We? Are you a real-school graduate?" "Yes, sir." "Well, you are the biggest exception of all." And, with that, he turned and left the room. The story, which is vouched for, needs no comment.

There is still another point to be considered. The practical object of these reports, as some professors conceived it, was to ascertain whether the faculties were in favor of excluding real-school students from the universities, and indeed the language of the request justified that view. Some voted for the reports, therefore, because they thought that the attendance at the universities is too large, and that the exclusion of real-school graduates offers a convenient means of getting rid of the surplus students. The writer visited twelve out of

the twenty-one German universities, during the last semester, in order to ascertain what is doing in the various departments in which he takes special interest. Everywhere the question was asked of university professors, "Do you think that too many are studying at the universities?" Almost uniformly the answer was returned, "There is no doubt about it." A few figures will make clear how rapidly of late years the number of students has increased. During the five years ending 1861, for every 100,000 inhabitants in Germany there were, on an average, thirty-two students in the universities. During the year 1881–'82 there were fifty-one students for the same number of inhabitants. Of these in the former period eight were enrolled in the philosophical faculty (the only faculty to which real-school students are admitted); in the latter period 20·7. That is, in a little more than twenty years the number of students in the philosophical faculty per 100,000 inhabitants has more than doubled. The average for the five years ending 1881 was eighteen, and the proportion is still increasing. This enormous increase in the number of students excites the gravest apprehension, and is characterized by thinking men as a sad state of affairs.

It may seem somewhat ludicrous to us to hear of an over-production of educated men. A German professor gave the key to the riddle, in a remark to the writer, that Germany is fostering the growth of an intellectual proletary—i. e., a class of professionally educated men for whom there is no room in the professions, and who are too proud to go into business of any sort. This state of affairs can not be fully appreciated without going further into detail than the limits of this article allow. Suffice it to say that the German universities are essentially professional schools. A man who enters such an institution intends to be a lawyer, a physician, a minister, teacher, professor, or member of the civil service of the country, and he receives there his professional training. It is easy to see that there can be an over-production in each and all of these fields. In this country such a state of things is easily remedied. If a man finds he has no chance to succeed as a lawyer, a year or two will turn him out a physician. If he fails in that, he can try theology, or he may go into business of some sort, or anybody can go into politics. In Germany the case is widely different. The Government demands such a long preliminary training and such intense and laborious effort in preparation, that, by the time a man finds there is no place for him in the profession he has chosen, his elasticity has gone, and there is no desire or ability to try anything else. To take up another profession he has become too old, and to go into mercantile or industrial life he is forbidden by his ideas of social position and scholarly dignity. To such a man two courses are open—to drag out a bare existence, with many wants which his education has developed, but which he has no means of gratifying, or—to commit suicide. Many take the latter alternative,

and the enormous increase in suicides during the last few years is one of the saddest and most striking phenomena of German society, high and low.

That there is an over-production in the professional fields nearly all German thinkers agree. How can it be helped? The Government has lately called the attention of parents and teachers to the fact that the higher administrative positions in the civil service are all provided for, and that all vacancies for years to come can be filled from the present candidates. The opponents of the real schools now come forward and say: "We can help the matter very easily. Shut out real-school graduates from the philosophical faculty and there will be room enough for the surplus students of law and medicine to find careers." Some professors voted for exclusion because they thought that the shutting out of real-school students would meet this rapidly-growing evil of over-production in professional spheres.

We think enough has been advanced to prove—1. That the Berlin report has little bearing on the question we are discussing in this country as to the respective merits of classical and modern training, for the simple fact that it was on an altogether different point. 2. That as to the particular subject, in regard to which it was prepared, it can lay no claim to be considered final, because it was made prematurely, at a time when the institution judged could, by the very nature of the case, have had no fair trial, and because it was made by prejudiced parties without sufficient investigation, and influenced by considerations which should have had nothing to do with the decision.

As a matter of fact, the opinion seems to be quite general in Germany that the real schools are bound to go forward to new struggles and to new conquests. They have lost none of the ground which they have ever won; they are gaining new ground every day. It is a mere question of time when the medical schools will be opened to them, and some even dare hope that the law schools must yield also. They may suffer temporary reverses, but they are sure to win in the long run. One significant fact may be noted, which is beginning to tell in their favor. The men in Germany who have made the deepest and longest studies in the science of education are assuming a more favorable attitude toward the real schools.

The writer recently visited Professor Masius, who holds a chair of Pedagogics in the University of Leipsic. He was for years the director of a gymnasium, then of a real school of the first rank, and then for years a member of the Ministry for Public Instruction in Saxony. On being asked what his position on the question of real school *vs.* the gymnasium is, he replied: "If you mean to ask me, whether the real-school graduates I get in my work are the equals of the gymnasium graduates, I should say, no! If you mean whether our real schools, as they are, afford as good a liberal training as the gymnasia, I should say, no! If you mean whether a real-school, as fully

equipped in regard to teachers and apparatus as an ordinary gymnasium, and with a simplified course of study, could give a liberal training equal to that afforded by the gymnasium, I should reply, I do not know, as the experiment has never been tried; but I am inclined to think it could."

The most advanced thinkers on pedagogics are coming to agree that the subject taught has much less to do with its value as a disciplinary and liberalizing study than the method of teaching it. Arithmetic may be so taught as to afford a much better training in language than half of our Latin and Greek teaching affords. There is a certain convertibility in the possible subjects in a curriculum with regard to liberalizing effects which is often lost sight of, but which our best thinkers on the science of education are more and more inclined to emphasize.

It has been already remarked that it is a dangerous procedure to apply concrete conclusions in one country to concrete conditions in another. The quoting of German authority in favor of a gymnasium course in order to bolster up the classical course of an average American college is a good instance in point. The German gymnasium gives nine hours a week for five years, and eight hours a week for four years more, to the study of Latin—i. e., seventy-seven hours a week for one year. It devotes to Greek seven hours a week for four years, and six hours a week for two years more—i. e., forty hours a week for one year, or to both languages the equivalent of one hundred and seventeen hours a week for one year. It will be stating it beyond the truth to put the time devoted to Latin in our average American college up to the close of the sophomore year at five hours a week for six years—i. e., thirty hours a week for one year, and to the Greek at five hours a week for five years—i. e., twenty-five hours a week for one year, or to both together the equivalent of fifty-five hours a week for one year. The German gymnasium thus gives more than twice as many hours to Latin and Greek as the average American college course. Now, the leading German authorities who favor a gymnasium course have repeatedly opposed lessening the amount of time devoted to these two subjects, and have expressed their opinion to the effect that any considerable reduction in the number of hours would be equivalent to depriving the course of all its value—i. e., so far from approving our classical curriculum, they unite in asserting that it is worth nothing whatever!

A part of President Porter's argument in the article already referred to proceeds on the assumption that the average college boy acquires enough Latin and Greek to be able to read it easily. Whatever may have been true in President Porter's college-days, the fact must appear evident to any one who has ever visited the sophomore classes in Greek in our American colleges, that the average boy does not acquire ability to translate even such an easy author as Xenophon

or Homer without difficulty—not even in Yale College; and the boy who takes up a Greek author and reads him for the pleasure that he derives from the thought is an *avis rara* indeed. It is the writer's opinion, based upon considerable investigation and comparison of notes with Greek teachers, both in America and Germany, that it is impossible for the average boy who spends the average amount of time on his Greek up to the close of his sophomore year to acquire the power of reading it easily. It is a universally admitted fact in Germany that the gymnasiast, who spends so much more time and labor than the American college boy, never acquires this power; and it is as true of the former as it is of the latter that the last day of his school-life is the last day of his Greek reading, with the exception of those following a profession which calls for a knowledge of the Greek, such as the philologists, philosophers, and clergymen.

One other point is worthy of notice. President Porter attempts to show that the main reason for unsatisfactory results in Greek study is the bad teaching of Greek which prevailed long ago, and which he hints has almost disappeared. That the teaching of Greek is now superior to what it was a generation ago we are very ready to believe, but it can hardly be said that there is any greater agreement among teachers as to the proper object of Greek study and the advantages to be derived from it. A visit to several of our leading colleges last winter, and conversation with the professors and instructors in Greek, revealed to the writer the very greatest differences of opinion, not only among the various colleges, but even among the representatives of that study within the same college. It is evident that the teachers who believe that the most important object to be attained is the ability to read Greek at sight, and to understand it without having to translate it, will pursue a very different method from those who see in the "incidental training" in grammar, logic, philology, etc., the chief benefit from Greek study. And yet the writer recently found these two opposite views held by two men in the same department of one of our leading colleges, the one of whom had one division of the sophomore class and the other the second division. It is hardly necessary to say that, however much the second may have benefited his class, the first did not get his division to read Greek at sight.

The writer does not wish to be misunderstood. He is making no attack on the study of Greek. He remembers well the keen pleasure and, as he thinks, profit with which he pursued the study of Greek under an exceptionally able series of teachers, and *his viris illustrissimis summas gratias agit, semperque habebit.* But he realizes well the great importance of these educational questions, and that many of them can never be settled except by actual experiment. It is of the highest importance that all things should be fairly tried, and that held fast which is good. It is demanded in the interests of society that modern education have a fair chance by the side of classical edu-

cation. That chance it has, as yet, nowhere had. Our colleges, so far as they have admitted scientific students, have allowed them to come in with a very inferior preparation. The French and German, and for that matter the English, too, in most of our colleges, are mere child's play, where they are not broad and ridiculous farces, the butt of students and professors alike. Let some of our colleges inaugurate the reform: lay out a "modern" course for admission and for college on the same general principle as the classical course—few subjects, but long-continued and detailed study in each of them—and insist on as thorough and vigorous work as they do in their Latin and Greek, and then, after a fair trial, compare results. The friends of "modern" education are willing to abide by the outcome. In the mean time it will be wise for the classicists to avoid quoting reports that have nothing to do with the question, and appealing to authority which, upon investigation, turns out to be squarely on the other side of the point in dispute.

EARLY COLONISTS OF THE SWISS LAKES.

By F. A. FOREL.

THE depression of the waters of the Lakes of Neufchâtel, Morat, and Bienne, which the Swiss Confederation has been having executed during the last ten years, has been a most fortunate event for archæologists; and with pick in hand, and on a relatively new ground, they have been able to recover hosts of treasures from the buried ruins of the lake-villages. The few scattered relics which they had succeeded in fishing up out of the water with tongs and drags have been multiplied into immense proportions since the hunters have been able to work upon the solid land that has been reclaimed from the edges of the favored lakes. By thousands and thousands the relics of human industry have been heaped up in the archæological collections, and the knowledge of the curious civilization of the early inhabitants of Switzerland has made, by the aid of these facts, very interesting progress. We need only cite, in proof of this, the very important memoir which Professor Théophile Studer has recently published in the "Bulletin" of the Society of Naturalists of Bern. Taking up, after M. L. Rütimeyer, of Basel, the study of the bones found in the archæological deposit of the *palafittes* (a term designating a wooden construction built on piles), and making use of the immense material collected from the stations of the Lake of Bienne, he has drawn from them most interesting details respecting the variations of the animal population during the different periods of these prehistorical ages, and respecting the progress of the domestication of the races useful to man.

A comprehensive account of the present condition of our knowledge of human industry in the lake epoch is furnished in the book just published by Dr. Victor Gross on "The Proto-Helvetians, or the Earlier Colonists of the Borders of the Lakes of Bienne and Neufchâtel"

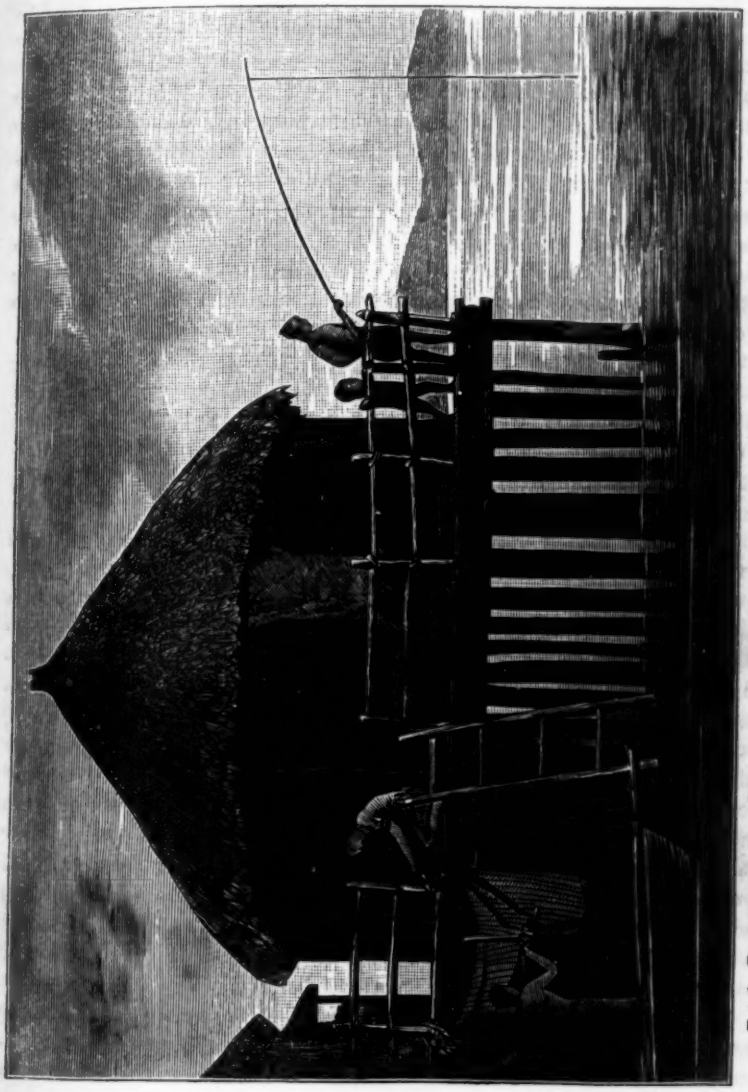

FIG. 1.—RESTORATION OF A DWELLING OF THE PRIMITIVE LAKE-VILLAGES OF SWITZERLAND. (After Dr. Victor Gross.)

("*Les Protohelvètes, ou les premiers colons des bords des lacs de Bienne et de Neuchatel*"). The author, a practicing physician at La Neuveville, on the shore of the Lake of Bienne, has had the good fortune to become possessed of products of all the special excavations made upon

that lake, and of a good part of the finds of the Lake of Neufchâtel, so that he has been able to form a collection unequaled in its richness, in the number of the specimens, and in the rarity of the pieces, frequently unique, that he has accumulated.

Wishing to give the scientific world a share in the enjoyment of these treasures, he has published in a beautiful quarto volume descriptions of the principal results of his researches, illustrated by photographic plates, in thirty-three of which are represented more than nine hundred and fifty of the more important pieces. I do not hesitate to style Dr. Gross's the finest known collection in prehistoric archæology, for while the series in some large museums may be more numerous than those of Dr. Gross, the latter have the superiority over all the others of relating to a single civilization, in different ages of its development, and to the same people in all the details of its intimate life with an incomparable luxury of illustration. The ruins of each one of our lake-villages may be compared to a Pompeii on a small scale. Let us suppose fifty Pompeiis, the destruction of which took place, one after another, during the ages from the primitive times of Roman history to the end of the decline of the empire, and we may be able to calculate what treasures of documents we might find in them wherewith to restore the history of industry, of art, and of civilization in ancient Italy.

The study of the larger collections of Swiss antiquities gives us a very clear impression of the wealth of the lacustrine populations, especially of the period known as the fine bronze age. We see in them universally evidences of abundant resources, and in no case of poverty. The inhabitants of the *palafittes* had at their disposal mechanical means, probably simple, but sufficient to fix in the ground the thousands and tens of thousands of piles on which they built their villages, Having an agriculture, and raising cattle, they were only exceptionally obliged to have recourse for food-supplies to the more primitive art of the chase. An extensive commerce brought them metals, amber, glass beads, and worked objects of foreign origin. A pure taste raised their artisans to the dignity of real artists. The reader who observes in Dr. Gross's plates the remarkable elegance of the designs of arms, of tools and ornaments of bronze, and of potter's work, like those represented in Fig. 2 (Nos. 1, 3, 4, and 10), can not deny that the civilization of the Swiss lake-dwellers was rich and flourishing.

The mass of metal they possessed was considerable; and, having regard to the innumerable pices of bronze found at some of the stations, I believe it will not be wrong to assert that in proportion to the population they had a weight of bronze at their disposal nearly equal to the weight of iron, aside from the heavy castings of the large agricultural machines, to be found in any of the most prosperous existing villages of the country. A figure will give an idea of this abundance and richness. M. Gross has made an account of the bronze pieces

FIG. 2.—ARTICLES FROM THE PREHISTORIC COLLECTION OF DR. VICTOR GROSS.

1. Bronze sword-handle (station of Mörigen).
2. Ornamented ear-drops (Auvernier).
3. Cup in hammered bronze (Corcelettes).
4. Clay vase, with incrustations from lamellæ of tin.
5. Comb of yew-wood (Fenil).
6. Bronze ear-drops (Auvernier).
7. Mold in sandstone, forming one of the shells of a mold for two knives and twenty-seven rings (Mörigen).
8. Hair-pin (Estavayer).
9, 10. Bronze knives (Auvernier).
11, 12. Ear-drops of deer-horn.

taken from the Lakes of Bienne and Neufchâtel, and makes the number 19,600, more than 5,000 of which are in his own collection.

The wealth of the Proto-Helvetians, as Dr. Gross happily calls them, so manifest in the bronze age, was also as real, though less evident, in the stone age. I come to this conclusion from the presence in the ruins of that period of some classes of objects that could have reached the country only by means of a very extensive commerce. Amber was brought to them from the shores of the Baltic Sea, and rare stones of very precious qualities, from which they made their cutting-tools, came to them from still farther; nephrite, a handsome stone, clear, green, and semi-transparent, was brought to them from Turkistan, or Southern Siberia; gray jade-stone came from Burmah; and *chloromélanite*, a black stone with yellow streaks, also probably came from Asia, but from beds that are still unknown. The lake period was of long duration, and included the whole time in which man rose by successive steps from the primitive stages of civilization in which he was not yet acquainted with metals to the higher stages, when he became acquainted with bronze and then with iron. Whatever a certain German school may say about it, the existence of a bronze age intermediate between the stone age and the iron age is demonstrated. That such a progressive and continuous development took place is proved with strong evidence from the archæological study of the products of human industry, and appears definitely in the study of the bones of animals gathered in the ruins of the lake-stations. In this respect, the conclusions of M. Studer are as affirmative and demonstrative as were twenty years ago those of M. Rütimeyer.

Dr. Gross distinguishes three successive periods in the stone age: A primitive, earlier period, making a poor showing of coarse potteries and imperfectly worked stones, with no nephrite or other stones of foreign origin. The station of Chavannes, near La Neuveville, is regarded by him as the type of that remote age. A second period exhibits the civilization of the stone age in all its glory. The stone instruments are finely cut, exotic stones are abundant, and the potter's art has reached an advanced degree of perfection. Locras and Latrigen represent this age on the Lake of Bienne. A third period bears evidence of the introduction of metals. The general character of the civilization remains the same as in the preceding age, with the same styles of pottery and the same abundance of stone implements. But the first tools of metal have been imported. At Finels, on the Lake of Bienne, we find copper worked in a manner still quite primitive; and at Mōrigen, in the station of Les Roseaux, we have bronze in the form of very simple hatchets. After this came the fine age of bronze, with its magnificent development of civilization; then, later, iron appeared.

Bronze, the metal chiefly in use in the finest age of the lake civilization, is not indigenous. Neither copper nor tin, the metals which alloyed with each other in proper proportions constitute this metal, is

found in the Swiss plain nor in the Jura. It is true that copper minerals exist in some of the valleys of the Alps, but it is very probable that the ancient lake-dwellers received the metal from more distant countries where the mines were more easily worked. With respect to tin, it is at any rate certain that the nearest beds are in Saxony, in Cornwall, and in Spain. It has long been debated whether these metals, tin, copper, and bronze, were brought to Switzerland already worked, or were cast on the spot; whether there was a local, native industry, or the arms, instruments, and ornaments were brought, having been already wrought out in foreign lands. It is now possible to answer the question. Some of the articles were imported already manufactured, for they evidently exhibit types of foreign industry. A superb vase of cast bronze and a fibula from Corcelettes, on the Lake of Neufchâtel, are preserved in the Museum of Lausanne, the form and ornamentation of which are manifestly Scandinavian. Other pieces, more numerous, recall forms of the south of France or of Italy. On the other hand, ingots or pigs of unworked metal are very rare in our finds. There was, however, also a local industry; and the lake-dwellers knew how to cast and hammer bronze in their own villages. We have proof of this in a relatively considerable number of molds deposited in the Swiss museums, among others at Lausanne, at Geneva, and in Dr. Gross's collection. In the plates illustrating the last collection are figured no less than three bronze molds, two of which are double, eight clay valves or fragments of molds, and seventeen molds or fragments in molasse (Fig. 2, No. 7). Sometimes one of the stone molds served for the casting of several objects; and the seventeen molds of Dr. Gross contain the matrices for seventy-two different pieces. Besides these molds, castings of bronze hammers, anvils, shears, and punches, complete the outfit of the founder, and demonstrate that his industry was indeed practiced on the spot. Whether the founder was a native, and established where he worked, or whether, like the tinkers of our own days, he was a foreigner and a wanderer, is a question to which a definite answer can not be returned. —*Translated for the Popular Science Monthly from La Nature.*

THE MORALITY OF HAPPINESS.

By THOMAS FOSTER.

III.—THE EVOLUTION OF CONDUCT.

As structures are evolved, so are the functions which structures subserve. And as the functions of the body are evolved, so are those combinations of bodily actions evolved which we include under the general term conduct.

We are considering the functions of the body when we are inquiring into such actions of the various structures internal and external as involve internal processes, simple or complex. But, when we begin to consider combinations of actions externally manifested, we are dealing with *conduct*—except only in the case of such actions as are independent of control.

But at the outset of the evolution of conduct even this distinction is scarcely to be recognized. Every external combination of actions is in the lower types of animal life a part of conduct—at least of such conduct as is possible in the lowest orders of creatures. Evolution of conduct begins with the gradual development of purpose where at first actions were random and aimless. The *Amœba* wanders from place to place, not by the action of limbs, but by a process which may be called diffluence. In so doing it may come into the neighborhood of objects fit to form its food; these it inwraps, and absorbing what is digestible rejects the rest. Or its wanderings may lead it into the way of some creature by which it is itself absorbed and digested. There may be some higher law than chance guiding the movements of such creatures; but so far as can be judged this is not the case. In other words there is but the suspicion of something like *conduct* in the actions of the Amœba. Among other creatures belonging to the same kingdom, but higher in type, we find actions so much better adjusted, that, though even yet we can not recognize such evidence of purpose as enables us to describe their actions as conduct, we yet see in their adjustment to certain ends the development of something akin to conduct. The actions seem guided by what mimics purpose if it is not purpose itself.

Now, we note that with the improved adjustment of actions comes an increase in the average duration of life, or rather in the proportion of this average to the length of life possible among these several creatures.

So when we pass to higher and higher orders of animals, we find in every case among the lower types irregular and seemingly purposeless actions, while among the higher we find actions better adjusted to the surroundings. And, again, we note that, where the combination of actions, or what we may now call the conduct, is not adjusted to the environment, the creatures' chances of life are small, great numbers dying for each whose life approaches the average duration. An improved adjustment of conduct to environment increases the chances of survival, many attaining and some passing the average of longevity in their particular type or order.

Now, structural development is guided by the fitness or unfitness of particular proportions in such and such structures for the great life-struggle in which all animal life is constantly engaged; and functional development is guided by the corresponding fitness or unfitness of such and such functional activities. Just as certainly the development of

conduct in all orders of living creatures is guided by the fitness or unfitness of such and such combinations of external actions for the constant life-contest.

We might find illustrations of this in every kingdom, sub-kingdom, order, and type, of animal life. Let us, however, content ourselves by noting it in man.

In the lower races of man as at present existing, and in still greater degree among the lower races when the human race as a whole was lower, we see that the adjustments of external actions to obtain food, to provide shelter against animate and inanimate enemies, and otherwise to support or to defend life, are imperfect and irregular. The savage of the lowest type is constantly exposed to the risk of losing his life either through hunger or cold, or through storm, or from attacks against which he has not made adequate provision. He neither foresees nor remembers, and his conduct is correspondingly aimless and irregular. The least provident, or rather the most improvident, perish in greatest numbers. Hence there is an evolution of conduct from irregularity and aimlessness by slow degrees toward the regularity and adaptation of aims to ends, seen in advancing civilization. The ill-adjusted conduct which diminishes the chances of life dies out in the struggle for life, to make way for the better-adjusted conduct by which the chances of life are increased. The process is as certain in its action as the process of structural evolution. In either process we see multitudinous individual exceptions. Luck plays its part in individual cases; but inexorable law claims its customary rule over averages. In the long run conduct best adapted and adjusted to environment is developed at the expense of conduct less suitable to the surroundings.

With man, as with all orders of animals, conduct which tends to increase the duration of life prevails over conduct having an opposite tendency. Wherefore, remembering the ever-varying conditions under which life is passed, the evolution of conduct means not only the development of well-adjusted actions, but the elaboration of conduct to correspond with those diverse and multitudinous conditions.

To these considerations we may add that the evolution of conduct not only tends necessarily to increased length of life (necessarily, because shortening of life means the diminution of such conduct as tends to shorten life), but it results in increased breadth of life, and (in the highest animal) in increased depth of life also. It is manifest that, in the elaboration of activities by which length of life is increased, breadth of life is increased *pari passu*. For these activities may be said to constitute breadth of life. Passing over the numerous illustrations which might be drawn from the lower orders of animal life, we recognize in man a vast increase in the breadth of life as we pass from the limited orders of activity constituting the life of the savage to the multiplied and complex activities involved in civilized life. In-

creased depth of life we recognize only (but we recognize it clearly) in the most advanced races of that animal which not only thinks and reasons but reflects.

We find, then, that the evolution of conduct is not only accompanied by increased fullness of life, but is to be estimated by such increase. We do not say that that conduct is good in relation to the individual which increases and that conduct bad which diminishes the fullness of individual life in the individual. We assert, for the present, only what observation shows—that conduct of the former kind is favored (other things equal), and therefore developed, in the life-struggle, while conduct of the latter sort tends to disappear as evolution proceeds.

Thus far we have only considered conduct in relation to individual life. We have still to consider the evolution of conduct as related to the life of the species.

In considering the evolution of structures and functions we have not only to consider the influence of the struggle for inidvidual existence, but also the effects of the contest in which each race as a whole is engaged—and to do this we have to consider, first, those circumstances which affect the propagation of the race; secondly, the relation of the individuals of the race to their fellows; thirdly, the relations of the race as a whole to other races. Something akin to this must be done in considering the evolution of conduct. We have seen how modes of conduct which favor the continued existence of the individual are developed at the expense of modes of conduct having an opposite tendency. These last die out, because the individuals of the race who act in these ways die out. But it is obvious that conduct will be equally apt to die out which tends to prevent or limit the adequate renewal of the race from generation to generation. It is equally obvious that whatever conduct causes contests (whether for life or subsistence) within the race or species, tends to the elimination of members of the race, and so diminishes the chances of the race in the struggle for existence with other races. Lastly, the relations of a race to surrounding races are manifestly of importance in the evolution of conduct, seeing that conduct will equally tend to be diminished whether it is unfavorable to the existence of the race in which it is prevalent, or simply unfavorable to the separate existence of an individual member of the race.

Now, with regard to conduct affecting the propagation of a race, we find that, like conduct affecting individual life, it has been developed from what can hardly be called conduct at all in the lowest grades of life to fully developed conduct, with elaborate adaptation of means to ends in the highest. In the lowest forms of life, propagation proceeds by mere division and subdivision, not depending so far as can be judged on any power of controlling the process, which such creatures may possess. In fact, the *Protozoa* multiply by dividing. We

have to pass over many grades of life before we reach such imperfect care for propagation of the race as we find among those orders of fish in which the male keeps watch and ward over the eggs. Still higher must we pass before we find any trace of affection for the young, and higher yet before we see care given to feed and protect and keep the young till they are able to provide for themselves.

This brings us in fact very near to the human race, which, in its lowest races, is distinguished from other animals chiefly by the length of time during which it feeds, protects, and trains its young. In the higher human races all these processes are conducted with greater care and elaboration; more varied wants are considered and attended to, more elaborately varied means are used for the purpose. It is easily seen how such conduct by aiding the development of the race aids the development of the conduct itself by which that result is favored. Among those members of a race in whom the proper race-propagating conduct is not adequately shown, propagation proceeds less effectively —which is the same as saying that, relatively, such conduct itself must be diminishing.

This conclusion is not inconsistent, as at first sight it might appear, with the fact that mere numerical increase of propagation, though it means increase in quantity of life, is not always or even generally a proof of the growth of the race in what may be called race-vitality. Here as elsewhere adaptation of means to ends has to be considered, and that kind of conduct by which such adaptation is secured has the best chances of development in the long run. Let us, for instance, take an illustration from civilized life: An early marriage between two persons, careless alike of present duties and future difficulties, seems at first to tend directly to the increase of carelessness and thoughtlessness; for from such a union there will probably come into existence more than the average number of offspring, repeating in greater or less degree the weak characters of their parents: the totality of life characterized by undesirable qualities and conduct will thus be increased, and increased in a greater ratio than the totality of prudent, steady, and thoughtful life, by a well-considered union and well-judged conduct thereafter. Yet in the long run the result proves usually otherwise. (We consider only average results.) The larger number of offspring of inferior qualities receive less care and inferior training; so that for them there is greater probability either of early death or of defective adult life. The parents suffer also in the struggle thus brought on them, for which they are ill-fitted. A diminished amount of life is likely to result, and (taking the average of many cases) probably does result; while certainly there is diminished life-quality. Hence results a correspondingly diminished amount and influence of the inferior kind of conduct shown by thoughtlessness or carelessness about life's duties. On the other hand, the well-judged and not too hasty union of two care-taking persons, though it may add a smaller number of

individual lives to the life of the race, adds better and more enduring life, life more likely to maintain and sustain the qualities of the parents, giving therefore to these qualities in the race at once more stability and wider influence. In other words, the qualities best suited for the propagation of the race, and best suited for the race, will on the average be developed, while qualities having opposite tendencies will either be eliminated, or though they may remain will occupy a lower place and have diminished influence on the fortunes of the race —a circumstance tending of itself still further to their eventual elimination.

But, within a race and in the relations of the race to other races, there are causes which influence the evolution of conduct. Members of a race fight out the contest for existence not alone but more or less in the presence of their fellows and in the presence of members of other races. Each individual in providing for his own wants or for his own defense affects more or less others, either of his own race or of other races, in their efforts to defend or sustain *their* lives. Very often, as Mr. Herbert Spencer quaintly puts it, "a successful adjustment by one creature involves an unsuccessful adjustment made by another creature, either of the same kind or of a different kind." The lion and the lamb, for instance, already anticipate the millennium; but the lion adjusts matters so much more successfully than the lamb as to take the outside place; the lamb lies down with the lion, but—inside. Among all races, herbivorous as well as carnivorous, similar relations exist. The more vigorous get the better food, food which the weaker contend for in vain or have to resign, when obtained, to superior strength. Within one and the same race there is still the same law. The stronger monopolize, if they can, the feeding-grounds of the race. The weaker, whether originally so, or become so through age or disease, succumb in greater numbers than the stronger in the struggle for existence. Only, while the death of those weak through age does not affect the evolution of the race, the greater mortality among those originally weaker than the rest modifies the race-qualities.

In these contests conduct plays an important part. Unnecessary contests involve unnecessary risks. That conduct must prevail best in the long run, and therefore that conduct must eventually be evolved and developed, by which adjustments for the advantage of one creature do not needlessly interfere with adjustments for the advantage of other creatures. If we imagine a carnivorous animal carefully limiting his search for animal food to his requirements, not killing where there was no occasion, and keeping carefully all food he had once obtained, we see that his chances in the life-struggle would be better than those of a carnivore of the same race who killed whenever he got the chance. It would be more the interest of other creatures (as for instance those who wanted the same sort of food) to eliminate

the carnivore of the latter sort, than to remove the more prudent member of the race. In the long run this would tell even among the lower animals. But, as we approach the relations of men to men and men to animals, we see more obviously how conduct in which the interests or the wants of others are considered is safer in the long run, more conducive (in hundreds of ways more or less complex) to prolonged existence, than conduct in which those interests and wants are neglected. Hence there will be a tendency, acting slowly but surely, to the evolution of conduct of the former kind. More of those whose conduct is of that character, or approaches that character, will survive in each generation, than of those whose conduct is of an opposite character. The difference may be slight, and therefore the effect in a single generation, or even in several, may also be slight; but in the long run the law must tell. Conduct of the sort least advantageous will tend to die out, because those showing it will have relatively inferior life-chances.

Mr. Spencer seems to me to leave his argument a little incomplete just here. For, though he shows that conduct avoiding harm to others, in all races, must tend to make the totality of life larger, this in reality is insufficient. He is dealing with the evolution of conduct. Now, to take a concrete example, those of the hawk tribe who left little birds alone, except when they had no other way to keep themselves alive but by capturing and killing them, would help to increase the totality of life, by leaving more birds to propagate their kind than would be left if a more wholesale slaughter were carried out. But this of itself would not tend to develop that moderation of hawk character which we have imagined. The creatures helped in the life-struggle would not be the hawks (so far as this particular increase in the totality of life was concerned), but the small birds; and the only kind of moderation or considerateness encouraged would be shown in a lessening of that extreme diffidence, that desire to withdraw themselves wholly from hawk society, which we recognize among small birds. But if it be shown that the more wildly rapacious hawks stand a greater chance of being destroyed than those of a more moderate character, then we see that such moderation and steadiness of character are likely to be developed and finally established as a characteristic of the more enduring races of hawks. And similarly in other such cases.

It is, however, in the development of conduct in the higher races only, that this comparatively elaborate law of evolution is clearly recognized. Among savage races we still see apparent exceptions to the operation of the rule. Individuals and classes and races distinguished by ferocity and utter disregard of the "adjustments" of others, whether of their own race or of different races, seem to thrive well enough, better even than the more moderate and considerate. Forces really are at work tending to eliminate the more violent and

greedy; but they are not obvious. As society advances, however, even this seeming success of the rapacious is found to diminish, though as yet there has been no race or society from which it has been actually eliminated. Conduct which is imperfect, conduct characterized by antagonisms between groups and antagonisms between members of the same group, tends to be more and more reduced in amount, by the failure or by the elimination of those who exhibit such conduct. What is regarded as gallant daring in one generation is scorned as ferocity in a later one, resisted as rapacious wrong-doing yet later, and later still is eliminated either by death or nearly as effectually (when indirect as well as direct consequences are considered) by imprisonment.*

As violence dies out, and as war diminishes—which usually is but violence manifested on a larger scale—the kind of conduct toward which processes of evolution appear to tend, "that perfect adjustment of acts to ends in maintaining individual life and rearing new individuals, which is effected by each without hindering others from effecting like perfect adjustments," will be approached. How nearly it will ever be attained by any human race—*quien sabe?*

One further consideration, and we have done with the evolution of conduct, the right understanding of which is essential to the scientific study of conduct. The members of a society, while attending to adjustments necessary for their wants or interests, may not merely leave others free to make their adjustments also, but may help them in so doing. It is very obvious that conduct thus directed must tend to be developed. As Mr. Spencer says, such conduct facilitates the making of adjustments by each, and so increases the totality of the adjustments made, and serves to render the lives of all more complete. But besides this (as he should also have shown, since it is an essential part of the evolution argument), it tends to its own increase: for, being essentially mutual, conduct of this kind is a favorable factor in the life-struggle.

We have next to consider what, seeing thus the laws according to which conduct is evolved, we are to regard as good conduct and bad conduct.

* Many overlook the bearing of imprisonment on the evolution of conduct—its influence (when long terms are considered) in diminishing the numerical increase of particular types of character, and therefore in diminishing the quantity of particular forms of conduct.

FEMALE EDUCATION FROM A MEDICAL POINT OF VIEW.*

By T. S. CLOUSTON, M. D.

AS the result of my inquiries among pupils and teachers in the advanced schools for young ladies, I find that about five or six hours of actual school-work, and from two to four hours of preparation at home, may be taken as the time that is each day occupied in education. Many of the ambitious, clever girls, in order to take high places and prizes, work far longer than the time I have mentioned in preparing at home, especially if the musical practicing is taken into account. At certain times of the year, before examination, some of these girls will work twelve and fourteen hours a day, and take no exercise to speak of, and but little fresh air. For those who attend the day-schools a somewhat solemn walk to and from school is the chief means the body has of keeping healthy at all. To satisfy the requirements of the brain, and the blood, and the muscles, and the digestion, and the nutrition, and the general growth, we have a girl getting up at seven o'clock in the dark winter morning, dressing, eating a hasty breakfast (as if that was a secondary matter that was too unimportant to waste much time over), having a revise of some special subject learned the night before, walking to school in perhaps thin-soled boots, and doing the most physiologically profitable thing of the day in the chat and gossip on the way. School and lessons from nine o'clock till two or three, or four often, in questionably aired, overheated, and dull class-rooms, with not a bright bit of paint or color in them to counteract the sunless gloom of our Scotch winter weather. Who ever saw a class-room in a school where taste had been exercised in the decoration and painting? In my opinion our school-rooms should be made at least as nice as our drawing-rooms. Then the walk home, a hurried dinner, a little rest, and to work till nine or ten o'clock at night in gas-light. That is the sort of life, and these are the conditions, under which we expect not only prodigies of learning in all the sciences, but sweet tempers and sweetly healthful bodies to be developed. That is the actual treatment to which thousands of our girls are subjected during the most momentous period of their lives, physiologically; when the growth of the body is being completed, its symmetry and perfection are being reached, when the latent energies for a life's work are being or should be accumulating, and when a certain amount of joy and fun and play is Nature's best aid to health of body and mind.

There is another class of young women who have even a harder lot in many cases, and these are the pupil-teachers in the board-schools.

* The second of two lectures delivered at the Philosophical Institution of Edinburgh, November, 1882.

Their work is, in some cases, simply continuous all day, and part of it is irksome, uninteresting drudgery; their homes are often far from being cheerful, and their food far from being very abundant. I know as a fact that the lives of some of our female pupil-teachers are such that as melancholy a "Song of the School" could be sung of them as Hood's "Song of the Shirt."

In both these cases—the scholars in the higher class of girls' schools and the female pupil-teachers—the range of subjects to be learned at the same time is often enormous. Six, seven, eight, nine, and even ten different subjects, all being learned at once, is no uncommon thing! I am glad to say that this is being corrected in the best schools, and only four or five subjects are allowed to be taught at the same time. This is surely enough.

If I had a school to construct on ideal principles, I should have it placed on the north side of a large space of ground. I should have it one story only, and every class-room lofty, and with roof-lights to let in as much as possible of our scanty Scotch sunlight. I should have the walls of the class-room painted in light, cheerful, tasteful colors, to produce a cheering effect on the minds of the pupils. I should have big, open fireplaces to cheer and to ventilate the rooms. I should have, as an essential adjunct, a great room, where gymnastics, romping, dancing, and play should all have full scope, when the weather did not admit of the girls going out. I should not restrain romping and play, even in girls of eighteen, between classes. Girls between thirteen and twenty will romp well, if they are in health, and there is no pressure put on them that it is not the thing for them to do. I should not have more than four hours of good hard work at school, and two of preparation at home. The fact is, that our scholars lose the benefit for their health of the best part of our Scotch winter days, the forenoon, when we sometimes have both sunshine and dryness in the air. By the time school is over, the day is done.

One of the practices most energetically relied on in the higher class of girls' schools is that of the competition of one scholar with another. In some of them this competition is terrific. It extends to every subject; it becomes so keen as to put each girl who is in the foremost rank in a fever-heat of emulation before the examinations. In some cases it overmasters every other feeling for the time being. No doubt, from the schoolmaster's point of view, it is the very thing he wants. In his professional enthusiasm he aims at the highest mental result. He is not professionally interested in the health or the special nervous constitution of his girls; he does not regard them as each one a medico-psychological entity and problem. I don't say this by way of reproach. All good men try to attain the highest result in their special departments. The educator has no means of knowing the constitution and hereditary weakness of his girls—that the mother of one died of consumption, that the father of another was insane, that neuralgia is

hereditary in the family of a third, that one has been nervous, another had convulsions when a baby, another has been threatened with water in the head, etc. His own education and training have not taught him to notice or know the meaning of narrow chests, or great thinness, or stooping shoulders, or very big heads, or quick, jerky movements, or dilated pupils, or want of appetite, or headaches, or irritability, or back-aches, or disinclination to bodily exertion. But all these things exist in abundance in every big school, and the girls handicapped in that way are set into competition with those who are strong and free from risks. It is the most nervous, excitable, and highly strung girls who throw themselves into the school competition most keenly. And they, of course, are just the most liable to be injured by it. All good observers say the intensity of feeling displayed in girls' competitions is greater than among lads, and that there is far more apt to arise a personal animus. Girls don't take a beating so quietly as boys. Their moral constitution, while in some ways stronger than that of boys, especially at that age, suffers more from any disturbing cause. The whole thing takes greater hold of them—is more real. It is more boys' nature to fight and forget, and take defeat calmly. Girls, I believe, suffer, when the competition in schools is too keen, in their tenderness of feeling and in their charity. They tend to attribute unfairness of motive to their teachers far more than boys, just because their affective nature is and should be stronger than their reasoning power. A man's idea of the perfection of feminine nature is, that it always has some self-denial and much generosity in it. Now, these keen school competitions admit in theory of no such notions of self-denial or generosity, though both are common enough in individual cases. An ideal woman should rejoice as much in sympathy with the winner of the first place as if she had won it herself. Men certainly don't, in their hearts, like to see girls competing keenly with each other for anything.

Young women at adolescence are apt to have in large degree the feminine power of taking it out of themselves for a time, more than they are able to bear for long. It is this power which enables a mother to watch a sick child for weeks without almost any sleep, and without feeling much sense of fatigue at the time. Now, when this power is called up for months for such a purpose as school competition—the feelings being stimulated by rivalry with others, and by the enthusiasm of that age, during a period of life when the body is undeveloped, and should be rapidly growing, and all these functions and faculties maturing—it is perverted from the real use that Nature meant it for, and the results can not fail to be bad. At that age girls are not only enthusiastic in perception and reception, but they are often very conscientious, and apply their ideas of right and wrong to things that have no ethical relationship. They are, in fact, hyper-conscientious, and make themselves unhappy about school deficiencies, for which

they are not in the least responsible. I have known girls cry bitterly because an accident or headache prevented them preparing their lessons for the morrow, and blame themselves severely about it. It is not uncommon for our Scotch girls, at least, to think it is some dereliction of duty and sin on their part that prevents them from attaining a high place at school. The whole process of education, as it exists in some schools, with its competition, long hours of work, short hours of recreation, enthusiasm for work, and conscientiousness in the doing of it, takes up all the available energy of the girl. There is little left for joyous feeling and enjoyment of life for its own sake. The sources of vital energy in the brain are not sufficiently replenished by fresh air and the frolic natural to the age. Blood is not formed in sufficient amount, and pale cheeks and flabby muscles are the result. Nature can not get material and force to build up the form toward the fair woman's ideal, and, therefore, personal beauty and grace of movement are not attained to the extent they should be. As for a store of energy being laid up, as it should be at that age, for the future, for woman's work of the future, for motherhood, for the race of the future, how can it be, when every available energy is taken up in this educative process?

The methods of education are nowadays made far more pleasant for a pupil than they were formerly. Every art and device is now adopted to make it attractive and interesting. That, no doubt, is in the right direction, and it has resulted from a closer study of the mental nature of pupils. But it is attended with this danger, that, being more attractive, it can be pushed further and more hurtfully to the constitution, by the aid of the pupils, as it were. Its very seductiveness and interest, like the tempting courses of a feast, tend toward dangerous surfeiting.

It must be remembered that, in many respects, the female organism is far more delicate than that of men. This is especially so at adolescence. The machine is less tough, and breaks down at slighter causes. It has more calls on it. It needs more careful management. It is not steady in its action, but irregular. It is not fitted for the regular grind that the man can keep up. Having beauty and harmony as two of its great ideal aims, its strength is not so great. Having to lay up more for the future, it can't expend so much in the present. Sensitiveness always implies delicacy, and in many cases instability in nature. Even suppose it is granted that it was a good thing for a woman that her brain should contain all the book-knowledge that many modern educationalists demand, this good thing might be altogether counterbalanced if the labor of acquiring it stopped one inch of growth, or diminished the joy and organic satisfaction of life one iota. If the men of the future were to suffer and be degenerate through it in the faintest degree, then it would be radically bad.

There is one most unaccountable want in very many girls' schools

in our cities. If boys need play, fresh air, games, muscular development, I have no hesitation in saying that girls need them all to the extent applicable to their constitution and strength still more. For boys will have them to some extent. If you don't give a boy a play-ground he will play on the street, which is better than no play. Now, the exigency of public opinion will not allow our young ladies to amuse themselves on the streets; and, if not, how are they to get the fresh air and muscular exercise that are absolutely necessary for their health and proper development? You can not starve a girl's life of these things without doing her harm, any more than you can with impunity keep her on a short allowance of food. A girls' school without a play-ground, a gymnasium, or public park near, I look on as a garden without sunshine, or a boat with one oar. It is deficient and one-sided; it is a machine for production without sufficient provision for the renovation of wear and tear. Mind can't grow except by growth of brain; brain can't grow but through good food, fresh air, work, and rest, in proper proportion. The blood will not renew itself properly in youth but by brisk circulation, and this can only be got by exercise in the fresh air. The muscles won't grow and harden but by having plenty of good blood and exercise. The fat, that most essential concomitant of female adolescence, won't form in the proper way, except the blood is rich. Fat is to the body what fun is to the mind, an indication of spare power that is boiling over and available for future use. I don't mean an excessive amount of fat; I mean that amount that gives roundness, plumpness, and beauty. This little estimated substance is, with form, the great source of female beauty. Without it, form can not make a perfect woman; without it, a young woman can not be said to be really in health; without it, the body generally has, in most instances, too little spare energy to resist and to recover from disease. Therefore, a proper amount of fat should, in its way, be as much looked to in a young woman as intellectual power or keen feeling. The right sort of fat, firm and smooth, gives the lines of beauty and the idea of softness and health to woman. But to the physiologist its great value and importance are as an index of good nutrition and a reserve of spare material, not needed for work just now, but called up in any illness. When anything is both a beauty and a strength, it should not be decried or spoken disrespectfully of. I knew a man—not a lunatic—who always said it was his highest ambition to be fat. Certainly there are many more foolish wishes for our growing adolescent girls than that they should all be fat. It is just because this seems to be incompatible with the work in some of our modern city high-class schools, that I think that work must be conducted to some extent on wrong principles.

I am no educationalist, and may be accused of speaking about what I am ignorant of, if I suggest that too many things are taught at the same time, and too little time is taken for the whole process.

Think of an undeveloped brain getting up book-knowledge on ten different subjects all the same day, and this going on day after day for years! It is altogether contrary to the principles of a sound psychology to imagine that any sort of mental process, worthy of the name of thinking, can take place in that brain while that is going on. The natural tendency of a good brain at that age to be inquisitive and receptive is glutted to more than satiety. The natural process of building up a fabric of mental completeness by having each new fact and observation looked at in different ways, and having it suggest other facts and ideas, and then settle down as a part of the regular furniture of the mind, can not possibly go on where new facts are shoveled in by the hundred day by day. The effect of this is bad on boys, but is worse on girls, because it is more alien to their mental constitution. The effect on them of this unnatural process is to exhaust the nervous power at the time, and to leave the brain afterward filled with useless things that are soon forgotten and pass away; as Goethe said about professional men: they labor under a great disadvantage in not being allowed to be ignorant of what is to them useless. The vital energies and nervous power that had thus been thrown away should have gone toward a feminine equipment of a healthy, well-developed body, a mind built up and stored with knowledge that had a relation to its own nature and to the wants of its future life, affections not attenuated by scholastic routine, and a cheerfulness that is only compatible with good health. The cramming up of the dry facts of those many subjects is in most cases a weariness and pain, while the intelligent study of one third of them, selected on account of their fitness to the mental constitution of the learner, or her probable requirements in future life, might be a pleasure and a lasting profit. I would strongly advise parents occasionally to take their daughters' night tasks and do them themselves. It is far more important to extend female education till after twenty years of age than male education.

While education is going on, a regular periodic testing of the bodily growth and condition should also be carried out in the case of every girl. Her rate of growth should be marked by a notch on a stick every quarter. As regularly as the school fees are paid her weight should be taken, the color of her cheeks and lips should be looked at and noted, her appetite and digestion should be looked to, her habits of activity or otherwise should be observed, her power of sleeping should be noticed, the mode of growth should be observed—e. g., whether her chest is expanding, whether her shoulders are sloping or stooping, whether she is soft or firm in the flesh, etc. Her general mental condition, whether she is frolicsome or irritable, enthusiastic or sluggish, selfish and grudging, or not, is of great moment as an index of the general brain-condition. Of course, anything like disorder of health, or pain, or sleeplessness, or want of appetite, or pallor, or

thinness, should be at once attended to before it goes too far. The great thing is to stop the beginnings of evil. If a girl has grown a couple of inches a year, then depend upon it she should not study hard. Nature has enough to do in such a case to firm up the body in proportion to its bulk. You want not only growth, but activity, grace of movement, alertness, strength. You won't have these if the girl goes on studying hard while she is growing fast.* If growth and increase in weight stop too soon, a wise parent will send off her daughter to the country to run to grass for a time, to see if mental inactivity will restore the body-growth. If she is getting thin, let her live out in the open air, instead of in a school, till her appetite becomes ravenous, and she puts on flesh.

There are three considerations that ought certainly to determine the mode, kind, and amount of the education given to any youth or maiden. These are—1. The hereditary constitution of the brain, including both its strong and weak points; 2. The actual ascertainable mental and bodily qualities and capacities and special tendencies of the child; and, 3. The purposes in life that he or she is destined to accomplish. It is owing to our backward physiological knowledge alone that the two former have not hitherto been taken into account, as they ought to have been, by doctors, parents, and teachers. In regard to heredity, when we know its laws more fully in human beings, we shall be able, by influences brought to bear on development and by appropriate conditions of life, greatly to counteract weak points, and to make strong ones available for the purposes of life. We are now able to do so to a considerable extent in the animal kingdom. Man has for his own purposes developed breeds of carrier-pigeons, race-horses, pointer-dogs, etc. We shall not be able to control the heredity of human beings as we can that of the lower animals, but we can apply conditions of life in a scientific manner for our aims. And, even in regard to the mode in which marriages are arranged, a medico-psychologist can not for a moment admit that young persons of either sex fall in love and assort themselves on no scientific principles. The sympathies and affinities of sex are just as much subject to law as any other part of nature. We doctors have much occasion to know that persons of a nervous heredity and disposition are extremely apt to fall in love with and marry each other. The way in which nervousness of all sorts is thus increased is extraordinary. The educators do their best to foster this tendency in the maidens by brain-forcing. The brilliancy of the results at the time are certainly very tempting.

* On October 1st I weighed and measured three children of one family, two boys and a girl, on their return to school after the holidays, and on November 30th I again did so. The boys had each gained four pounds in weight and grown half an inch, the girl had neither gained nor grown. The boys had had lots of play in the open air between lessons, the girl had been five hours each day continuously in school. The boys' class-rooms had been built for a school, the girl's class-rooms were in a small private house.

It may be that it will be for the advantage of the world deliberately to develop different kinds of men and women in the future. We may get better general results by having brain specialties fostered. We may thus have some families of special æsthetic power, some of mechanical genius, and some of enduring muscular work, just as we have pointers, greyhounds, and sheep-dogs. But even then it would be more than ever necessary to see that the special strong point did not override and interfere with the general nutritive power and vital energy. In training a greyhound, however anxious the trainer is to get speed, he takes care that the dog is very well nourished while he grows, and he never develops his speed till the growth is nearly done, and the bones are set. He doesn't all the time he is growing run the animal every day. He knows that would spoil the general strength, and shorten the period of greatest activity.

The development of special strong points during the process of the education of children I believe to be of vast importance to the race, but it must be done in accordance with Nature's general laws that govern the development of the organism as a whole. The special education must be accompanied by the general development. It must not be pushed to the extent that it absorbs energy needed for other purposes. I can imagine no more interesting or important problem in education than the successful cultivation of specialties. It is quite certain that as yet it has not been solved or even studied to any extent. If you hear of a young lady now who is very musical, you usually find she has so much music added to the grammar and the French and German. It is as important in education to know what things to omit as to know what things to press. It is enough to make one despair of the inherent reasonableness of human nature to think of the amount of time and toil that are given in Edinburgh to the learning of things for which there is no inherent capacity in the learners; things that go against the intellectual grain, that are learned poorly and with much difficulty, against Nature; and are forgotten at once, in accordance with Nature's laws. Think of the girls who toil at music, who have no inherent musical capacity; of the time that is taken in committing to memory rules of grammar, and doing parsing, the real meaning of which the girls' brains could not comprehend, if they lived till they were ninety; of the labor and sorrow given to acquire languages, by girls whom Nature meant only to speak their mother-tongue; of the futile attempts to take those past the rule of three, whom Nature intended to stop at simple division. The sad thing is that we all know each of those girls could do something or other very well and to some purpose in after-life, if we could only hit on what it is.

I don't want to frighten any one unduly by the list of bodily and mental diseases and defects that are in some cases attributable to wrong methods of education that I am about to refer to. I would beg every

one who hears me to keep in mind that the worst of such things are the exception. No process of attempted educational stimulation will do much harm to very many brains, fortunately as I think. Their inherent stability—which, by-the-way, parents and teachers will ignorantly call stupidity or want of application—sometimes preserves them from being forced into work inconsistent with their bent and capacity. Who does not know dozens of fine girls—capable, practical, intelligent, affectionate, lively—who never could be made scholars of, and yet who know more that will be useful to them than some of the first prize-women? They never ran any risk of suffering from over-education, their only risk was badly ventilated school-rooms and want of scope for play. It is very difficult, I know, to treat of the professional aspect of a question popularly without producing misconceptions. If a case of consumption from ill-ventilated school-rooms is referred to, many people jump to the conclusion that all girls are in danger of consumption. Nothing could be more absurd. The fact is that, if we and our families were thoroughly healthy in original constitution, the educationalists and their present over-enthusiastic methods would not hurt our daughters so very much, perhaps, at least permanently. Nature would call a halt with sufficient distinctness before much harm was done, and then the wondrous recuperative power of that time of life would soon put matters right again. It is because few persons nowadays have faultless constitutions, and few families are altogether free from tendencies to some disease or other, that one needs to be now more careful of the constitutions of the mothers of the next generation.

The first bodily defect to which I shall refer, as the result of over-stimulation of brain, is what we doctors call *anæmia*, or in other words bloodlessness. The girls look pale about the lips, and have no rosy cheeks. This is manifestly most common in school-girls. Any one can see it.

The next faulty bodily condition that may be caused by wrong methods of education is that of stunted growth. I have seen girls, the daughters of well-grown parents, who simply stopped growing too soon. They are more or less dwarfish specimens of their kind, this being caused, as I believe, by the vital and nervous force being appropriated by the mental part of the brain in learning its tasks, and by the conditions of life in the school-rooms not being good, the air bad, insufficient play-hours, no play-ground, no play-room, no walking in the fresh air and sunshine. I have seen other girls who grew tall enough, but wouldn't fatten. They remained thin and scrawny. Now, this is not what a woman should be at any age if it can be helped.

The next condition sometimes produced is best described by the word *nervousness*. That is a condition of mind and body in which there is want of stability and fixity, undue excitability, bodily restlessness, want of solidity and calmness of constitution, ungrounded fears,

deficient power of self-control, over-sensitiveness in all directions, and a very great many other unpleasant things, far too numerous to mention here. This nervousness is commonly hereditary, but may be greatly aggravated or counteracted by the conditions of life, especially in youth. Such a constitution is a great curse to a woman, and renders her liable to many diseases. It means a brain wanting in reserve or surplus energy. Such a brain is like a galvanic battery that does not work steadily, but gives out too much power at one time, then suddenly is exhausted, and is always needing replenishing. There can be but little doubt that the tendency of our modern life is toward the development of the nervous type of constitution, or *diathesis*. American physicians and socialists are unanimous that this constitution is very common in their country. I think there can be little doubt that, if we wish our descendants to multiply and cover the earth, we should try by all means and counteract this tendency to the nervous constitution in a morbid degree. It is most hereditary in all its forms. There are few families among the educated classes nowadays free from some taint of it, and it is easily increased. In the families that are now free there is much risk of its being developed in the period of adolescence in the girls, through the present system of education. All our modern ways of looking at life help to develop nerves in a bad sense. The ideal of man and woman has changed from strength to culture, from body to brain. The great brawny-muscled man, who knows nothing of sickness, but has few ideas, is looked down on ; the rosy mother of a dozen healthy children, who has no taste for books, is little thought of. It may be that the time will come when such people will be more highly appreciated. Out of the nervous diathesis may arise all the forms of nervous disease, when their exciting causes are put in operation.

Strongly connected with nervousness is the tendency to suffer from pain without any actual disease being present to account for it ; that is, to be the subject of headaches and neuralgias. Headache is the most common thing suffered by school-girls, and originated by the conditions of school-life. Dr. Truchler found that in Darmstadt, Paris, and Nuremburg, one third of the pupils in the schools suffered more or less from headaches. I think we should find this proportion in our advanced girls' schools in Edinburgh. He concludes that it is caused by the intellectual exertion, combined with bad air, with the annoyances and excitements and worries, the wasting and rasping anxieties of school-life. Nothing is so terrible as severe neuralgia, and beyond a doubt girls acquire it often enough by the conditions of school-life. Headaches in a school-girl usually mean exhausted nerve-power through overwork, over-excitement, over-anxiety, or bad air. Rest, a good laugh, or a country walk, will usually cure it readily enough to begin with. But to become subject to headaches is a very serious matter, and all such nervous diseases have a nasty tendency to recur, to become periodic, to be set up by the same causes, to become

an organic habit of the body. For any woman to become liable to severe neuralgia is a most terrible thing. It means that while it lasts life is not worth having. It paralyzes the power to work, it deprives her of the power to enjoy anything, it tends toward irritability of temper, it tempts to the use of narcotics and stimulants.

There is but little doubt that a tendency to take stimulants to excess, a morbid craving for alcohol, or drugs that have something like the same effect, goes with the nervousness engendered by school-life. A healthy brain in a healthy body should have no inordinate craving for stimulants. Some of the worst examples I have seen of a craving for stimulants or opium, having become uncontrollable and a real disease, have been in our highly-educated ladies. Tea sometimes is craved for, and taken to excess in such cases.

The most important effect of all I can not very well enter on in detail, for it relates to woman's highest function, that of motherhood. But that this is affected, and most seriously, by over-education in bad methods and under bad conditions, no physician will deny. If the end of mind-culture is to be that its victim is to suffer in a more terrible way from mother Eve's primal curse, and is to have fewer offspring, and those she has are to be of a puny kind, the risk will be recognized by all thoughtful persons as too severe to be deliberately run for our daughters. Perfect health is a priceless blessing to all, but it means even more to women than to men. The cheerfulness and vivacity that are their special characteristic, seem to exist not for themselves alone, but for their families as well, and those are, generally speaking, wanting if the health is bad. Woman is gifted with the power not only of bearing her own share of ills, but of helping to bear those of others. She can't do so in the same degree if she is not in health. She is a plant more difficult to rear than man in our state of society. More care has to be taken of her to mature and consolidate all her organs and functions. Once fully formed as a woman, she can then stand much, but she is specially liable to the effects of adverse conditions during her development. The full bloom of her perfection as the tender mother, the never-tiring nurse of a large family of children, can not be attained if she has been stunted in her full development in any way. Whether she is an actual mother or not, she is infinitely the better for having the full capacity of motherhood. Be she teacher, scholar, or lady of fortune, she will be happier and do her work far better, if she has all the qualities of motherhood. They influence body and mind; any process of education that lessens them deprives the world of means of happiness. It stunts the woman and robs the world. No intellectual results, no culture, no mental elevation, can make up to the world for the loss of any perceptible degree of motherhood; and, as an actual fact, physicians find that over-education by bad methods and under bad conditions has this effect.

The first appearance of the conditions called *hysteria* is usually

coincident with adolescence, and is undoubtedly caused in many instances by subtile disturbances of the health, due to prolonged school-hours. This is a most troublesome disease, and most varied in its manifestations. In nothing is the connection between mind and body, between function and feeling, better seen than in certain hysterical conditions. You have a splendidly educated girl according to the modern standard, with a physique that seems very fairly developed, just showing by certain subtile indications that the mental portion of the brain has been made too dominant. You have this girl prostrated in what seems the most mysterious way by hysteria, in one of its hundred forms. You can't actually say what is wrong, but you know that, if she had been brought up in the country, with moderate schooling, and four or five hours a day in the open air, there would not have occurred anything of the kind. It may result from idleness just as it does from over-brain-work, the one being as much contrary to the laws of nature as the other. It is an illustration of the fact that you may have effects produced by wrong methods of education that are not to be detected till they break out in actual disease. If the seeds of disease or the conditions that tend to it are laid by any system of training, it is nearly as bad as actual visible disease. Sometimes it is said about the girls in a school, "Just look at them, are they not fairly healthy for town girls who are working hard?" But one of the dangers is that we may not be able to see the beginnings of evil, and only by sad experience afterward find that they were there.

The last kinds of disease to which I shall refer as being a direct or indirect result, in some cases, of over-study under bad conditions, are inflammation of the brain and its membranes, and insanity—the former of which all physicians have often enough seen to be the direct result of over-study; while the latter may be regarded, in its essential nature, as the acme of all nervous diseases. In it, that highest portion of the brain that ministers directly to mind is disordered, that very portion that in over-education has been forced and crammed with book-knowledge. Mental disease is not common till toward the end of the period of adolescence, but the conditions that lead up to it are common enough before then. The mere acquiring knowledge seldom causes insanity. Its causes in youth are all the conditions of life that accompany over-education, as well as the brain-forcing itself, the want of fresh air, the poor bodily development, the poverty of blood, the deranged undeveloped bodily functions. Insanity in early youth always arises out of some nervous weakness in ancestry. It may not be mental disease itself—for a tendency to neuralgia or drunkenness, or mere nervousness in ancestors, may become insanity in the offspring, if wrong conditions of life are in operation. But it is often just the children of highly nervous parents—perhaps subject to "nervous depression"—who are quick, precocious, and educable in book-

knowledge to a very high degree. They get pushed to their bent, and with all this they have little craving for fresh air and romping. They are often over-conscientious and most receptive. In fact, they are the very young women that delight the heart of the teacher, and sometimes carry off all the prizes at the end of a school session. The treatment of the teacher and the physician would be exactly opposite for such cases. The physician would take such brains to put them to grass for two or three generations—would scarcely educate them at all in the ordinary sense—would send them to grow up almost uninstructed in the country, cultivating blood, bone, muscle, and doing mechanical work alone. That would be the only salvation for such brains. But then we should perhaps miss having a genius once in a century. We should have our Chattertons working as joiners in the country, instead of writing poetry and committing suicide in town garrets. I could adduce many lamentable examples, from my own experience, of most brilliant school careers ending in insanity. If I had written down the fierce apostrophe of a young lady of twenty on her entry into the asylum at Morningside, at the end of a school career of unexampled success, the reading of it would do more to frighten the ambitious parents of such children from hastening their daughters forward at school too fast than all the scientific protests we doctors can make. She was well aware of the cause of her illness, and with passionate eloquence enumerated the consequences of her losing her reason.

It is not very long since a pupil-teacher, who had been working all winter about ten hours a day in teaching and preparation, and had taken no exercise or fresh air at all, after suffering for a while from headaches and confusion of mind, threw herself into a pond. She told me afterward that the harder she worked the more confused she got, then she got depressed, and then lost her self-control.

There can be no doubt that too hard school-work in young women during the adolescent period tends to bring out hereditary, nervous, and other weaknesses. The great natural protection against these is sound health and general bodily vigor in a frame that has been brought carefully to full maturity, harmonious and healthy in all its functions. This law is found to prevail in regard to nervous hereditary weaknesses, that the stronger and more direct the tendency, the earlier in life such weakness is apt to show itself. If we can postpone it, we can frequently avert it altogether.

Of the chief purely mental results of a brain-education higher than the whole organization can bear, one is unquestionably a certain change in the natural mental type of woman. I shall be asked, of course, What is the natural female psychical type? Is it to be found in the uneducated women of the East, or among the uncultivated classes of the West? Without going into argument, I may say that I should be willing to take the general character of womanliness pervading all the various

types of young women created for us by the writers of genius, to whom I referred in my first lecture. That type is physiologically, as well as psychologically, true to nature. It is absolutely necessary as a complement to the masculine type of mind. Both are incomplete by themselves. The world can not do without them both; they correspond to the bodily organization of each sex. Now, if the education process for the female is to be just on the lines of that for the male, if the mold into which the brain of each is to fit is to be the same type—and there is no question of emasculating the male type—then, undoubtedly, in the result, we must expect to find a change in the female type of mind. Very many competent observers say that this is actually very apparent in some of the school-girls of the present day. The unceasing grind at book-knowledge, from thirteen to twenty, has actually warped the woman's nature, and stunted some of her most characteristic qualities. She is, no doubt, cultured, but then she is unsympathetic; learned, but not self-denying. The nameless graces and charms of manner have not been evoked as much as they might have been. Softness is deficient. It takes much to alter the female type of mind, but a few generations of masculine education will go far to make some change. If the main aims and ambitions of many women are other than to be loved, admired, helped, and helpful, to be good wives and mothers with quiverfuls of children, to be self-sacrificing, and to be the centers of home-life, then those women will have undergone a change from the present feminine type of mind. But we must comfort ourselves with Lord Bacon's reflection, that "Nature is often hidden, sometimes overcome, seldom extinguished."

American experience in the education of young women has been very instructive. The natural intelligence, the form of government, and the stimulating climate, have all united in making the standard of education very high for women as well as for young men. The national hurry has tended to make them do much in as short a time as possible too. In the Eastern States—especially Massachusetts—the schools for girls have for many years been most highly elaborated. At first the effects were not much noticed, or they were attributed to the climate, or to the hurry of life, or to the national fondness for pastry; but soon the American physicians sounded the alarm about the way the New England girls were being educated. They pointed out that during education a high pressure was kept up in girls that no constitutions could stand without risk. They pointed to the thinness and the nervousness of American young women. Oliver Wendell Holmes directed attention to the "American female constitution, which collapses just in the middle third of life, and comes out vulcanized India-rubber, if it happens to live through the period when health and strength are most wanted." It was shown how small the families of educated American native-born women were, as compared with those of their German and English sisters, and with the Irish living

among themselves. Dr. Clarke, in his most instructive book, "Sex in Education; or, a Fair Chance for Girls," pointed out to the American people the risks of forcing young women's brains, and the actual consequences that American physicians found to have resulted from that process. After pointing out that, as a matter of fact, girls in American schools work seven or eight hours a day, he says: "Experience teaches that a healthy and growing boy may spend six hours of force daily on his studies, and leave sufficient margin for physical growth. A girl can not spend more than four, or, in occasional instances, five hours of force daily upon her studies, and leave sufficient margin for the general physical growth that she must make in common with a boy, and also for her own development." In Dr. Beard's book on "American Nervousness: its Causes and Consequences," he says that, as the result of a large number of circulars sent to schools, the replies were sufficient to clearly show that "nearly everything about the conduct of the schools was wrong, unphysiological and unpsychological, and that they were conducted so as to make very sad and sorrowing the lives of those who were forced to attend them. It was clear that the teachers and managers of these schools knew nothing of and cared nothing for those matters relating to education that are of the highest importance, and that the routine of the schools was such as would have been devised by some evil one who wished to take vengeance on the race and the nation. . . . Everything pushed in an unscientific and distressing manner, nature violated at every step, endless reciting and lecturing and striving to be first—such are the female schools of America at this hour. The first signs of ascension as of declension in nations are seen in women. As the foliage of delicate plants first shows the early warmth of spring and the earliest frosts of autumn, so the impressible, susceptive organization of woman appreciates and exhibits far sooner than that of man the manifestation of national progress or decay."

It must be distinctly understood that my facts and arguments only apply to the young woman of average type and of average strength. There are plenty of individual examples, where there is naturally so much brain and strength that a very high kind of general masculine education can be given from thirteen to twenty without impairing the development. In such brains there is room for much learning and much affection and many charms. The reasoning power, the muscles, the fat, and the affections may be all equally developed in them.

It may be too, I am not prepared to deny it, that an education may be good for the individual in many cases, opening up sources of intellectual happiness, that is bad for the race. On the other hand, there is some truth in Beard's aphorism, that "ignorance is power as well as joy" to many men and women.

From a scientific point of view, I am well aware that the weak

point of my argument is, that it is not founded on any basis of collated statistical facts. I have said to you, "I and many other physicians and physiologists have seen many undoubted instances of girls being hurt by over-education under bad conditions," but we can not say that out of every hundred girls such a percentage do suffer. We have not the facts to enable us to do so. I hope such facts will be recorded in the future, and may be all the more likely to be observed and recorded through attention being directed to the matter. I am well aware, too, that teachers are not most to blame for any bad results that are to be attributed to the present system of over-educating girls. Parents and the spirit of the time are more culpable than teachers. The latter are the public's servants, and must do the public's bidding. They are expected to work "The Code" energetically, to earn large grants, to make bricks without much straw in many cases, to turn out omniscient governesses and teachers in a few short sessions. Parents cry out to them about their children, "They are idle," if the whole evening is not taken up with lesson-learning, or if the animal spirits are too high or the holidays too long. I could tell some sad tales of brain break-down in overworked teachers, male and female, if that were not beyond the scope of this lecture.

I went last July to see the examination and distribution of prizes in a very large city school for young ladies. While the young girls there were very many of them fresh in complexion and plump, I must say that the majority of the girls above thirteen seemed to me jaded, and pale, and unduly thin. I did not see a dozen pairs of rosy cheeks in a hundred of them. To my eye, many of them bore very evident signs of over-brain-work and deficient physical energy. They didn't look joyous and full of animal glee, as girls at that age should look. Like Dr. John Brown's terrier, "life was too full of seriousness" to them. Two Sundays after, I was in a country kirk in the far north, where modern educational systems are as yet unknown, and I contrasted the appearance of the farmers' daughters there with that of the prize-winners in the city school. The difference was absolutely astounding. I only wish I could convey the impression I received in both cases from a critical doctor's survey of both sets of girls. If the one set exemplified health, robustness, organic happiness, strength, resistive power against disease, and potential motherhood, then, beyond a doubt, the other set did not fully do so. The question of the future is, How can we get, or how much can we get of, the intelligence and book-culture of the latter, combined with the health of the former? The health we must have, for it is requisite for the life of the race; the culture we must have in such degree as is consistent with the health.

THE CONTROL OF CIRCUMSTANCES.

By WILLIAM A. EDDY.

IN a previous article, we noticed that even circumstances which seem to result in accumulations involving vast lapses of time are seen to be temporary when considered with relation to very great and to us inconceivable periods. The stability is apparent only, and is due to our limited grasp of duration. The study of averages is valuable as showing the proportion of control attainable through knowledge of the limit of variation in certain kinds of events. It would require something like omnipresent intelligence to cope with the enormous variability in all events, so that were it not for the perception of identity, repetition, the law of probability, we would be as completely helpless in regard to circumstances as many claim we are. In extending this question of averages, demonstrating the illusion of chance, we see that the appliances of science and intelligence must lessen helplessness and misery with every coming century, although, owing to limitation of the individual, the control can never be anything like complete. It is important that we form right ideas of the control possible, so that we be neither like Don Quixote, who thought his power almost without limit, nor like a fatalist who resigns himself to the current of events. In the history of progress, we see that during centuries some suffering might have been escaped by a more complete knowledge of causes, as well as by better intellectual training resulting in more foresight. The delayed relief was and is due to crude methods of scientific thought and experiment, lack of that insight or flash of analogy by which all great truths are discovered. The power to group and combine complex results, shown by the most advanced minds when working under favorable conditions, is hardly sufficient for even a vague understanding of the development of diseased conditions. The mind is led step by step toward the truth, by means of scientific experiments. At last, Pasteur and others disclose the laws which account for some kinds of progressive destruction in the movements of organic or inorganic particles.

As we begin to comprehend vaguely the laws of events, and the importance of action as an element of modifying power—as we stand back and include a great number of incidents in our generalization—we see more relation between action and result. The direct importance of objective action, its immediate interest for us, is in considering the proportion of control which we can exert. This is one of the most complicated problems, because special thwartings conceal the control when we look from the "near point of view of daily life." Several years of experience are required to demonstrate the proportion of truth in the well-known business maxim that it is better to

avoid joining fortunes with an unlucky man. Much of the misfortune is in the man's quality; for we say of the successful man that, if a given project fails, he still has something in reserve. He has foreseen and provided for failure, and has great power of readjusting his vocation in an emergency. Besides an accumulation of money, which he has thrown up as an embankment between himself and disaster, he has an even stronger reserve force in his knowledge of human nature, his address, and his strength of character. In this sense the average indicates that prolonged effort results in control. He reaches a point in after-years when the special event conforms to his effort easily.

But we must not overlook the conditions that limit success. There is a margin of uncertainty in the fact that the successful man is seen to suffer from temporary calamities, which clearly are not due to his action or inaction. We find an outward influence completely beyond his control. The fact that it can be conquered by perseverance and knowledge does not lessen its irresistible force in the present. The outer forces, largely social but not less powerful than those of organization and physical law, do not respond to his efforts—seem arrayed against him, or turn unexpectedly in his favor. It thus appears that the question of control might easily result in endless debate, because each side—the triumph of circumstances or of human will and perseverance—includes part of the truth. While admitting that the tendency is persistently in favor of effort, we yet find a positive conclusion impossible to hold. The control, even under favorable conditions, is incomplete. It is true we can not express this with even relative accuracy, yet a rough idea of the truth may be given by a statement of arithmetical proportion as applied to a large number of men having successful qualities—such as knowledge of human nature and perseverance. The proportion of control will seem much greater if we consider the effect upon a given calling or condition toward which the effort tends. When a person starts in life with one object —say, that of making money—and uses every available means to accomplish his purpose, saving and constantly watching the public wants with the intention of supplying them, working night and day at a sacrifice of social recreation, the average, we may say, is as high as ninety per cent that he will succeed. Many will put the possibility of failure at much less than ten per cent; but if the question be carefully considered, it will be admitted that sickness and other causes may make inroads upon prosperity, so that of a hundred persons with such qualities, ten might fail after a given lapse of time, owing to conditions beyond their control.

While noticing the proportion of failure which may result in spite of prolonged effort, we must not omit the immense differences due to the qualities with which men are born. This is the most important of all the conditions considered. After deducting a large number of exceptions, we would doubtless still find the balance heavily in favor

of the children of efficient parents. It therefore follows that, although we can not trace the control absolutely to effort in the individual, we can still find a part of the difference accounted for in the efforts of a line of ancestors, or in parents whose special aptitudes, perhaps attained directly by work, are united with magnifying effect in one of their children.* If we go back of the effective qualities of men, we encounter the unfathomable fact of the persistence of force; for the most important characteristic of these effective qualities is a certain mechanical motive power. It may be possible to definitely separate the force in men into the presence or absence of different kinds of it in a line of ancestors, but ultimately we are obliged to say that the first impulse took place for the same reason that the earth persists in its course round the sun, or for the same reason that motion appears to be an inevitable attribute of matter. Of course this is not accounting for it. It is simply reducing the question to a point of fact beyond which further investigation is apparently useless. In estimating our power of control, the right method is to start with the qualities existing, or latent, and then proceed to their effects. We may say, with Herbert Spencer, that special forms of thought-force were built up through processes of action and adjustment, but, as involved or noticed in his conclusions, this only dissolves the existing special manifestations of force into a general but at the same time unaccountable force.

While the enormous magnitudes and forces in nature remind us of our helplessness, it is yet clear that the tendency to master distant facts is constantly stimulated by natural phenomena. We ought not to be discouraged by the fact that exceptional events are not always classified or reduced to order by us—their connection is often lost, owing to our limited grasp of duration—nor by the truth that as natural phenomena recede from us we are more conscious of problems beyond the circumstances or surroundings which we partly control. Many apparent disconnections gradually lead us away from the series close at hand. The heavenly bodies, for example, manifest so much variation in movement and brightness, that men are led to undertake increasingly difficult or more delicate tasks of calculation, as in estimating the distances of α Centauri, Sirius, Vega, and other stars. Another result is, that attempts are made to form at least a theoretical idea of the physical conditions of suns and planets through knowledge attained by means of the spectroscope. The conclusions thus reached are necessarily imperfect because based upon fragmentary data, but the mental tendency to inquire is with scientific minds inevitable, because there are always appearing, with every increase of telescopic power, other stars beyond those last discovered.

It thus appears that while the high aims of Plato and Aristotle find

* A certain artist seems to have inherited his father's habit of keen observation and his mother's mechanical ingenuity. Very often, however, these characteristics can not be definitely traced back.

justification in the idea that effort is taught by nature, even when a definite result is invisible, yet the teachings of physical causation show that it is vain to expect an escape from some material trammels. We see the vibration of two apparently opposing social forces, in which the high and more intelligent force is slowly gaining the ascendency by a process of adaptation, so that the physical force is becoming a source of power to men instead of fear. Emerson's conclusion, like that of Kant, is two-sided—that the principle of mind is manifested to us through material action. This holds true aside from Kant's "Forms of Thought" on one hand, or Herbert Spencer's relations between particles on the other. We can not have the unalloyed mind-power or control usually wished for, because our demands are unreasonable in the sense that we would dispense with the necessary and lower conditions upon which the higher depend, and thus thrust out causation, which is the principle of combination or order by which error and absurdity could be escaped if the relations between events were completely mastered. This mastery of physical power represents an ideal condition in which the mind is no longer enslaved by forces that seem material or mechanical.

In closing with a general view of this subject, we encounter the following contradiction: During a long period we see that fortunes and reputations grow by means of industry, and that a high percentage of the men having these industrious qualities accomplish their purpose. On the other hand, it is obvious that many of the physiological phenomena of the human body, the varying limitation of thought in individuals, and especialy the universe of matter, are not appreciably influenced by our actions or ideas. The idea of possible control narrows from a solar system to a planet, to a particular part of planetary surface, to a special series of effects, and to special kinds of callings. The arguer can truthfully claim that we have no control, and hold his position by referring to the material universe and the development of mankind; but particular kinds of effort when so considered undermine his argument as applied to immediate results of actions. In arguing on the other side, he can maintain as truthfully, to put the same idea in different form, that the control is almost complete, but he must apply his argument to special and restricted conditions.

It has been denied that we can trace with certainty any manifestation of law in circumstances; that there is a fatal error in conclusions regarding the inevitableness of causation or law; that there is no perceptible law, because everything shows a margin of variation which may reach inconceivable results in the course of ages. Law, as understood by a member of the Theosophical Society, means the exact repetition of previous conditions, owing to vast averages and inconceivably great lapses of time.* The argument as to whether phenomena are

* This definition of law was advanced by one of the younger members of the society. It may not fairly represent the views of all the members.

exactly repeated is apparently of no consequence, as long as average results are known. The notion of infinite variation, as thus implied, is defective because the identity underlying the variation is omitted. It is fair to assume that identity will keep pace with variation, and that the margin of variation must always involve continuity, or a further illustration of the order or law manifested by the phenomena considered. The history of science shows that the new relations do not render absurd the verified conclusions of reason, though much is added that has to be classified and as far as possible reduced to a reasonable basis. In fact, the variations are seen to verify the known sequences instead of lessening their certainty. We may therefore assume that vast, far-reaching forces, or forms of force now unknown, will never even seem to interfere with the obvious and seemingly necessary laws manifested by known phenomena. Such interference of unknown laws would be, as far as we could perceive, a break in continuity, or causation, and the inflow of obvious absurdity. From this point starts the root of superstition; for persons without perception of the causation underlying all action endow the unknown forces with power to produce effects at variance with the simplest forms of sequence, the disturbance of which would at once render void the human intellect. Are we to believe that gloves were sent from Bombay to London in an instant, thus setting aside one of the first laws of matter learned in childhood? If such monstrous phenomena occur, then it is useless to think that we can trace method in circumstances.

All the evidence so far collected indicates that actions and results are related, and we are thus encouraged by the thought that no work is wasted—that it must stand to the credit of the worker. When the effect upon others is not discernible, we can be sure that the advantage still exists as latent force of character. The value of work remains good in spite of vicissitudes. This may seem trite, but we must remember that the relation between work and effect is constantly observed in a partial light, so that people are likely to be either fatalists like Micawber, or to look upon a special failure as inexcusable and as a certain indication of quality. It has been the object of this outline of so complicated a question to modify these opposing views, to encourage effort, to emphasize the rational perception of the continuity or order pervading events, and to put aside as far as possible the fearful possibilities with which some endow the mysterious power everywhere manifested in nature. As long as we feel conscious that the unknowable reality can never involve anything irrational, ill-fitting the harmony and grandeur of the sidereal universe, we feel that ideas may lessen the burdens of men, widen their thought, and teach them that these persistent effects following causes may be depended upon with entire trust. Meantime the progress of men in intelligence, toward a certain degree of happiness, continues. One of the principal factors of this advancement is that all should sincerely express personal convic-

tion. The decline of intelligence and of our power to control circumstances may be conceived as beginning when old ideas are advocated merely because the first impression is that they are plausible, and particularly when certain books, purely intellectual, are avoided merely because the reader fears to find something unanswerable and convincing. By all means let us have free trade in ideas, from the theory of materialization advanced by Robert Dale Owen at one extreme to the scientific exactness of Herbert Spencer at the other. Let there be no protection of ideas, and let each one maintain its hold by virtue of its truth and power. Owing to the varying tendencies and views of men, the truth overlooked by one may be seen by another, so that if we encourage the expression of peculiar combinations or combining powers in minds, much suffering arising from our lack of knowledge may be escaped. Those who do not realize the value of ideas ought to reflect that, largely owing to our want of ingenuity and perception, we are still in the main at the mercy of particles in ways which could be spared us if we knew or had discovered more, or had more control of the onward march of the closely knit network of events and influences that make up our short lives. Lack of observation in a trifling matter, or short-sighted heed to the convenience of the present hour, may restrict the possible development of the finest powers, and so the development of intelligence, by widening these limits, indirectly as well as directly, may add to the power of men in a steadily increasing proportion. Those who do not see the helping power of science, or at least the promise of it, ought to remember that every omission to use the best intelligence in themselves, or to encourage it in others, results in a continuance of the amount of pain and disappointment now existing, which can only be lessened by the general development of intelligence, and by the use of the increasingly difficult and more subtile researches of men of science.

RELIGIOUS RETROSPECT AND PROSPECT.*

By HERBERT SPENCER.

UNLIKE the ordinary consciousness, the religious consciousness is concerned with that which lies beyond the sphere of sense. A brute thinks only of things which can be touched, seen, heard, tasted, etc.; and the like is true of the untaught child, the deaf-mute, and the lowest savage. But the developing man has thoughts about ex-

* This article will eventually form the closing chapter of "Ecclesiastical Institutions"—Part VI of "The Principles of Sociology." The statements concerning matters of fact in the first part of it are based on the contents of preceding chapters. Evidence for nearly all of them, however, may also be found in Part I of "The Principles of Sociology," already published.

istences which he regards as usually inaudible, intangible, invisible; and yet which he regards as operative upon him. What suggests this notion of agencies transcending perception? How do these ideas concerning the supernatural evolve out of ideas concerning the natural? The transition can not be sudden; and an account of the genesis of religion must begin by describing the steps through which the transition takes place.

The ghost-theory exhibits these steps quite clearly. We are shown that the mental differentiation of invisible and intangible beings from visible and tangible beings progresses slowly and unobtrusively. In the fact that the other-self, supposed to wander in dreams, is believed to have actually done and seen whatever was dreamed, in the fact that the other-self when going away at death, but expected presently to return, is conceived as a double equally material with the original, we see that the supernatural agent in its primitive form diverges very little from the natural agent—is simply the original man with some added powers of going about secretly and doing good or evil. And the fact that, when the double of the dead man ceases to be dreamed about by those who knew him, his non-appearance in dreams is held to imply that he is finally dead, shows that these earliest supernatural agents have but a temporary existence: the first tendencies to a permanent consciousness of the supernatural prove abortive.

In many cases no higher degree of differentiation is reached. The ghost-population, recruited by deaths on the one side, but on the other side losing its members as they cease to be recollected and dreamed about, does not increase; and no individuals included in it come to be recognized through successive generations as established supernatural powers. Thus the Unkulunkulu, or old-old one, of the Zooloos, the father of the race, is regarded as finally or completely dead, and there is propitiation only of ghosts of more recent date. But where circumstances favor the continuance of sacrifices at graves, witnessed by members of each new generation who are told about the dead and transmit the tradition, there eventually arises the conception of a permanently-existing ghost or spirit. A more marked contrast in thought between supernatural beings and natural beings is thus established. There simultaneously results a great increase in the number of these supposed supernatural beings, since the aggregate of them is now continually added to; and there is a strengthening tendency to think of them as everywhere around, and as causing all unusual occurrences.

Differences among the ascribed powers of ghosts soon arise. They naturally follow from the observed differences among the powers of the living individuals. Hence it results that while the propitiations of ordinary ghosts are made only by their descendants, it comes occasionally to be thought prudent to propitiate also the ghosts of the more dreaded individuals, even though they have no claims of blood.

Quite early there thus begin those grades of supernatural beings which eventually become so strongly marked.

Habitual wars, which more than all other causes initiate these first differentiations, go on to initiate further and more decided ones. For, with those compoundings of small social aggregates into greater ones, and recompounding of these into still greater, which war effects, there, of course, with the multiplying gradations of power among living men, arises the conception of multiplying gradations of power among their ghosts. Thus in course of time are formed the conceptions of the great ghosts or gods, the more numerous secondary ghosts, or demi-gods, and so on downward—a pantheon: there being still, however, no essential distinction of kind; as we see in the calling of ordinary ghosts *manes*-gods by the Romans and *elohim* by the Hebrews. Moreover, repeating as the other life in the other world does, the life in this world, in its needs, occupations, and social organization, there arises not only a differentiation of grades among supernatural beings in respect of their powers, but also in respect of their characters and kinds of activity. There come to be local gods, and gods reigning over this or that order of phenomena; there come to be good and evil spirits of various qualities; and where there has been by conquest a superposing of societies one upon another, each having its own system of ghost-derived beliefs, there results an involved combination of such beliefs, constituting a mythology.

Of course, ghosts primarily being doubles like the originals in all things, and gods (when not the living members of a conquering race) being doubles of the more powerful men, it results that they, too, are originally no less human than ordinary ghosts in their physical characters, their passions, and their intelligences. Like the doubles of the ordinary dead, they are supposed to consume the flesh, blood, bread, wine, given to them: at first literally, and later in a more spiritual way by consuming the essences of them. They not only appear as visible and tangible persons, but they enter into conflicts with men, are wounded, suffer pain: the sole distinction being that they have miraculous powers of healing and consequent immortality. Here, indeed, there needs a qualification; for not only do various peoples hold that the gods die a first death (as naturally happens where they are the members of a conquering race, called gods because of their superiority), but, as in the case of Pan, it is supposed, even among the cultured, that there is a second and final death of a god, like that second and final death of a ghost supposed among existing savages. With advancing civilization the divergence of the supernatural being from the natural being becomes more decided. There is nothing to check the gradual dematerialization of the ghost and of the god; and this dematerialization is insensibly furthered in the effort to reach consistent ideas of supernatural action: the god ceases to be tangible, and later he ceases to be visible or audible. Along

with this differentiation of physical attributes from those of humanity there goes on more slowly the differentiation of mental attributes. The god of the savage, represented as having intelligence scarcely if at all greater than that of the living man, is deluded with ease. Even the gods of the semi-civilized are deceived, make mistakes, repent of their plans; and only in course of time does there arise the conception of unlimited vision and universal knowledge. The emotional nature simultaneously undergoes a parallel transformation. The grosser passions, originally conspicuous and carefully ministered to by devotees, gradually fade, leaving only the passions less related to corporal satisfactions; and eventually these, too, become partially dehumanized.

These ascribed characters of deities are continually adapted and readapted to the needs of the social state. During the militant phase of activity, the chief god is conceived as holding insubordination the greatest crime, as implacable in anger, as merciless in punishment; and any alleged attributes of a milder kind occupy but small space in the social consciousness. But, where militancy declines and the harsh despotic form of government appropriate to it is gradually qualified by the form appropriate to industrialism, the foreground of the religious consciousness is increasingly filled with those ascribed traits of the divine nature which are congruous with the ethics of peace: divine love, divine forgiveness, divine mercy, are now the characteristics enlarged upon.

To perceive clearly the effects of mental progress and changing social life, thus stated in the abstract, we must glance at them in the concrete. If, without foregone conclusions, we contemplate the traditions, records, and monuments, of the Egyptians, we see that out of their primitive ideas of gods, brute or human, there were evolved spiritualized ideas of gods, and finally of a god; until the priesthoods of later times, repudiating the earlier ideas, described them as corruptions: being swayed by the universal tendency to regard the first state as the highest—a tendency traceable down to the theories of existing theologians and mythologists. Again, if, putting aside speculations, and not asking what historical value the "Iliad" may have, we take it simply as indicating the early Greek notion of Zeus, and compare this with the notion contained in the Platonic dialogues, we see that Greek civilization had greatly modified (in the better minds, at least) the purely anthropomorphic conception of him: the lower human attributes being dropped and the higher ones transfigured. Similarly, if we contrast the Hebrew God described in primitive traditions, manlike in appearance, appetites, and emotions, with the Hebrew God as characterized by the prophets, there is shown a widening range of power along with a nature increasingly remote from that of man. And, on passing to the conceptions of him which are now entertained, we are made aware of an extreme transfiguration. By a convenient

obliviousness, a deity who in early times is represented as hardening men's hearts so that they may commit punishable acts, and as employing a lying spirit to deceive them, comes to be mostly thought of as an embodiment of virtues transcending the highest we can imagine.

Thus, recognizing the fact that in the primitive human mind there exists neither religious idea nor religious sentiment, we find that, in the course of social evolution and the evolution of intelligence accompanying it, there are generated both the ideas and sentiments which we distinguish as religious, and that, through a process of causation clearly traceable, they traverse those stages which have brought them, among civilized races, to their present forms.

And now what may we infer will be the evolution of religious ideas and sentiments throughout the future? On the one hand, it is irrational to suppose that the changes which have brought the religious consciousness to its present form will suddenly cease. On the other hand, it is irrational to suppose that the religious consciousness, naturally generated as we have seen, will disappear and leave an unfilled gap. Manifestly it must undergo further changes; and, however much changed, it must continue to exist. What, then, are the transformations to be expected? If we reduce the process above delineated to its lowest terms, we shall see our way to an answer.

As pointed out in "First Principles," § 96, Evolution is throughout its course habitually modified by that Dissolution which eventually undoes it: the changes which become manifest being usually but the differential results of opposing tendencies toward integration and disintegration. Rightly to understand the genesis and decay of religious systems, and the probable future of those now existing, we must take this truth into account. During those earlier changes by which there is created a hierarchy of gods, demi-gods, manes-gods, and spirits of various kinds and ranks, Evolution goes on with but little qualification. The consolidated mythology produced, while growing in the mass of supernatural beings composing it, assumes increased definiteness in the arrangement of its parts and the attributes of its members. But the antagonist Dissolution eventually gains predominance. The spreading recognition of natural causation conflicts with this mythological evolution, and insensibly weakens those of its beliefs which are most at variance with advancing knowledge. Demons and the secondary divinities presiding over divisions of Nature become less thought of as the phenomena ascribed to them are more commonly observed to follow a constant order, and hence these minor components of the mythology slowly dissolve away. At the same time, with growing supremacy of the great god heading the hierarchy, there goes increasing ascription to him of actions which were before distributed among numerous supernatural beings: there is integration of power. While in proportion as there arises the consequent conception of an omnipotent and

omnipresent deity, there is a gradual fading of his alleged human attributes: dissolution begins to affect the supreme personality in respect of ascribed form and nature.

Already, as we have seen, this process has in the more advanced societies, and especially among their higher members, gone to the extent of merging all minor supernatural powers in one supernatural power; and already this one supernatural power has, by what Mr. Fiske aptly calls deanthropomorphization, lost the grosser attributes of humanity. If things hereafter are to follow the same general course as heretofore, we must infer that this dropping of human attributes will continue. Let us ask what positive changes are hence to be expected.

Two factors must unite in producing them. There is the development of those higher sentiments which no longer tolerate the ascription of inferior sentiments to a divinity; and there is the intellectual development which causes dissatisfaction with the crude interpretations previously accepted. Of course, in pointing out the effects of these factors, I must name some which are familiar; but it is needful to glance at these along with others.

The cruelty of a Feejeean god, who, represented as devouring the souls of the dead, may be supposed to inflict torture during the process, is small compared with the cruelty of a god who condemns men to tortures which are eternal; and the ascription of this cruelty, though habitual in ecclesiastical formulas, occasionally occurring in sermons, and still sometimes pictorially illustrated, is becoming so intolerable to the better-natured that, while some theologians distinctly deny it, others quietly drop it out of their teachings. Clearly, this change can not cease until the beliefs in hell and damnation disappear. Disappearance of them will be aided by an increasing repugnance to injustice. The visiting on Adam's descendants, through hundreds of generations, dreadful penalties for a small transgression which they did not commit; the damning of all men who do not avail themselves of an alleged mode of obtaining forgiveness, which most men have never heard of; and the effecting a reconciliation by sacrifice of one who was perfectly innocent—are modes of action which, ascribed to a human ruler, would call forth expressions of abhorrence; and the ascription of them to the Ultimate Cause of things, even now felt to be full of difficulties, must become impossible. So, too, must die out the belief that a Power present in innumerable worlds throughout infinite space, and who during millions of years of the earth's earlier existence needed no honoring by its inhabitants, should be seized with a craving for praise, and, having created mankind, should be angry with them if they do not perpetually tell him how great he is. Men will by-and-by refuse to imply a trait of character which is the reverse of worshipful.

Similarly with the logical incongruities more and more conspicuous to growing intelligence. Passing over the familiar difficulties that sundry of the implied divine traits are in contradiction with the divine attributes otherwise ascribed—that a god who repents of what he has done must be lacking either in power or in foresight; that his anger presupposes an occurrence which has been contrary to intention, and so indicates defect of means—we come to the deeper difficulty that such emotions, in common with all emotions, can exist only in a consciousness which is limited. Every emotion has its antecedent ideas, and antecedent ideas are habitually supposed to occur in God: he is represented as seeing and hearing this or the other, and as being emotionally affected thereby. That is to say, the conception of a divinity possessing these traits of character necessarily continues anthropomorphic; not only in the sense that the emotions ascribed are like those of human beings, but also in the sense that they form parts of a consciousness which, like the human consciousness, is formed of successive states. And such a conception of the divine consciousness is irreconcilable both with the unchangeableness otherwise alleged and with the omniscience otherwise alleged. For a consciousness constituted of ideas and feelings caused by objects and occurrences can not be simultaneously occupied with all objects and all occurrences throughout the universe. To believe in a divine consciousness, men must refrain from thinking what is meant by consciousness—must stop short with verbal propositions; and propositions which they are debarred from rendering into thoughts will more and more fail to satisfy them. Of course, like difficulties present themselves when the will of God is spoken of. So long as we refrain from giving a definite meaning to the word will, we may say that it is possessed by the Cause of All Things, as readily as we may say that love of approbation is possessed by a circle; but, when from the words we pass to the thoughts they stand for, we find that we can no more unite in consciousness the terms of the one proposition than we can those of the other. Whoever conceives any other will than his own must do so in terms of his own will, which is the sole will directly known to him—all other wills being only inferred. But will, as each is conscious of it, presupposes a motive—a prompting desire of some kind: absolute indifference excludes the conception of will. Moreover, will, as implying a prompting desire, connotes some end contemplated as one to be achieved, and ceases with the achievement of it: some other will, referring so some other end, taking its place. That is to say, will, like emotion, necessarily supposes a series of states of consciousness. The conception of a divine will, derived from that of the human will, involves, like it, localization in space and time: the willing of each end, excluding from consciousness for an interval the willing of other ends, and therefore being inconsistent with that omnipresent activity which simultaneously works out an infinity of ends. It is the same

with the ascription of intelligence. Not to dwell on the seriality and limitation implied as before, we may note that intelligence, as alone conceivable by us, presupposes existences independent of it and objective to it. It is carried on in terms of changes primarily wrought by alien activities—the impressions generated by things beyond consciousness, and the ideas derived from such impressions. To speak of an intelligence which exists in the absence of all such alien activities is to use a meaningless word. If, to the corollary that the First Cause, considered as intelligent, must be continually affected by independent objective activities, it is replied that these have become such by act of creation, and were previously included in the First Cause, then the reply is that in such case the First Cause could, before this creation, have had nothing to generate in it such changes as those constituting what we call intelligence, and must therefore have been unintelligent at the time when intelligence was most called for. Hence it is clear that the intelligence ascribed answers in no respect to that which we know by the name. It is intelligence out of which all the characters constituting it have vanished.

These and other difficulties, some of which are often discussed but never disposed of, must force men hereafter to drop the higher anthropomorphic characters given to the First Cause, as they have long since dropped the lower. The conception which has been enlarging from the beginning must go on enlarging, until, by disappearance of its limits, it becomes a consciousness which transcends the forms of distinct thought, though it forever remains a consciousness.

"But how can such a final consciousness of the Unknowable, thus tacitly alleged to be true, be reached by successive modifications of a conception which was utterly untrue? The ghost-theory of the savage is baseless. The material double of a dead man in which he believes never had any existence. And if by gradual dematerialization of this double was produced the conception of the supernatural agent in general—if the conception of a deity, formed by the dropping of some human attributes and transfiguration of others, resulted from continuance of this process—is not the developed and purified conception reached by pushing the process to its limit a fiction also? Surely, if the primitive belief was absolutely false, all derived beliefs must be absolutely false."

This objection looks fatal; and it would be fatal were its premise valid. Unexpected as it will be to most readers, the answer here to be made is that at the outset a germ of truth was contained in the primitive conception—the truth, namely, that the power which manifests itself in consciousness is but a differently-conditioned form of the power which manifests itself beyond consciousness.

Every voluntary act yields to the primitive man proof of a source of energy within him. Not that he thinks about his internal expe-

riences; but in these experiences this notion lies latent. When producing motion in his limbs, and through them motion in other things, he is aware of the accompanying feeling of effort. And this sense of effort which is the antecedent of changes directly produced by him becomes the conceived antecedent of changes not produced by him—furnishes him with a term of thought by which to represent the genesis of these objective changes. At first this idea of muscular force as anteceding unusual events around him carries with it the whole assemblage of associated ideas. He thinks of the implied effort as an effort exercised by a being wholly like himself. In course of time these doubles of the dead, supposed to be workers of all but the most familiar changes, are modified in conception. Besides becoming less grossly material, some of them are developed into larger personalities presiding over classes of phenomena which, being comparatively regular in their order, foster the idea of beings who, while far more powerful than men, are less variable in their modes of action. So that the idea of force as exercised by such beings comes to be less associated with the idea of a human ghost. Further advances, by which minor supernatural agents become merged in one general agent, and by which the personality of this general agent is rendered vague while becoming widely extended, tend still further to dissociate the notion of objective force from the force known as such in consciousness; and the dissociation reaches its extreme in the thoughts of the man of science, who interprets in terms of force not only the visible changes of sensible bodies, but all physical changes whatever, even up to the undulations of the ethereal medium. Nevertheless, this force (be it force under that statical form by which matter resists, or under that dynamical form distinguished as energy) is to the last thought of in terms of that internal energy which he is conscious of as muscular effort. He is compelled to symbolize objective force in terms of subjective force, from lack of any other symbol.

See now the implications. That internal energy which in the experiences of the primitive man was always the immediate antecedent of changes wrought by him—that energy which, when interpreting external changes, he thought of along with those attributes of a human personality connected with it in himself—is the same energy which, freed from anthropomorphic accompaniments, is now figured as the cause of all external phenomena. The last stage reached is recognition of the truth that force as it exists beyond consciousness can not be like what we know as force within consciousness; and that yet, as either is capable of generating the other, they must be different modes of the same. Consequently, the final outcome of that speculation commenced by the primitive man is, that the Power manifested throughout the universe distinguished as material is the same Power which in ourselves wells up under the form of consciousness.

It is untrue, then, that the foregoing argument proposes to evolve

a true belief from a belief which was wholly false. Contrariwise, the ultimate form of the religious consciousness is the final development of a consciousness which at the outset contained a germ of truth obscured by multitudinous errors.

Those who think that science is dissipating religious beliefs and sentiments seem unaware that whatever of mystery is taken from the old interpretation is added to the new. Or, rather, we may say that transference from the one to the other is accompanied by increase; since, for an explanation which has a seeming feasibility, it substitutes an explanation which, carrying us back only a certain distance, there leaves us in presence of the avowedly inexplicable.

Under one of its aspects scientific progress is a gradual transfiguration of Nature. Where ordinary perception saw perfect simplicity it reveals great complexity; where there seemed absolute inertness it discloses intense activity; and in what appears mere vacancy it finds a marvelous play of forces. Each generation of physicists discovers, in so-called "brute matter," powers which, but a few years before, the most instructed physicists would have thought incredible; as instance the ability of a mere iron plate to take up the complicated aërial vibrations produced by articulate speech, which, all translated into multitudinous and varied electric pulses, are retranslated a thousand miles off by another iron plate and again heard as articulate speech. When the explorer of Nature sees that, quiescent as they appear, surrounding solid bodies are thus sensitive to forces which are infinitesimal in their amounts—when the spectroscope proves to him that molecules on the earth pulsate in harmony with molecules in the stars—when there is forced on him the inference that every point in space thrills with an infinity of vibrations passing through it in all directions—the conception to which he tends is much less that of a universe of dead matter than that of a universe everywhere alive: alive, if not in the restricted sense, still in a general sense.

This transfiguration, which the inquiries of physicists continually increase, is aided by that other transfiguration resulting from metaphysical inquiries. Subjective analysis compels us to admit that our scientific interpretations of the phenomena which objects present are expressed in terms of our own variously-combined sensations and ideas —are expressed, that is, in elements belonging to consciousness, which are but symbols of the something beyond consciousness. Though analysis afterward reinstates our primitive beliefs, to the extent of showing that behind every group of phenomenal manifestations there is always a *nexus*, which is the reality that remains fixed amid appearances which are variable, yet we are shown that this *nexus* of reality is forever inaccessible to consciousness. And when, once more, we remember that the activities constituting consciousness, being rigorously bounded, can not bring in among themselves the activities beyond

the bounds, which therefore seem unconscious, though production of either by the other seems to imply that they are of the same essential nature, this necessity we are under to think of the external energy in terms of the internal energy gives rather a spiritualistic than a materialistic aspect to the universe; further thought, however, obliging us to recognize the truth that a conception given in phenomenal manifestations of this ultimate energy can in no wise show us what it is.

While the beliefs to which analytic science thus leads are such as do not destroy the object-matter of religion, but simply transfigure it, science under its concrete forms enlarges the sphere for religious sentiment. From the very beginning the progress of knowledge has been accompanied by an increasing capacity for wonder. Among savages, the lowest are the least surprised when shown remarkable products of civilized art, astonishing the traveler by their indifference. And so little of the marvelous do they perceive in the grandest phenomena of Nature that any inquiries concerning them they regard as childish trifling. This contrast in mental attitude between the lowest human beings and the higher human beings around us is paralleled by the contrasts among the grades of these higher human beings themselves. It is not the rustic, nor the artisan, nor the trader, who sees something more than a mere matter of course in the hatching of a chick; but it is the biologist, who, pushing to the uttermost his analysis of vital phenomena, reaches his greatest perplexity when a speck of protoplasm under the microscope shows him life in its simplest form, and makes him feel that however he formulates its processes the actual play of forces remains unimaginable. Neither in the ordinary tourist nor in the deer-stalker climbing the mountains above him does a Highland glen rouse ideas beyond those of sport or of the picturesque; but it may, and often does, in the geologist. He, observing that the glacier-rounded rock he sits on has lost by weathering but half an inch of its surface since a time far more remote than the beginnings of human civilization, and then trying to conceive the slow denudation which has cut out the whole valley, has thoughts of time and of power to which they are strangers—thoughts which, already utterly inadequate to their objects, he feels to be still more futile on noting the contorted beds of gneiss around, which tell him of a time, immeasurably more remote, when far beneath the earth's surface they were in a half-melted state, and again tell him of a time, immensely exceeding this in remoteness, when their components were sand and mud on the shores of an ancient sea. Nor is it in the primitive peoples who supposed that the heavens rested on the mountain-tops, any more than in the modern inheritors of their cosmogony who repeat that "the heavens declare the glory of God," that we find the largest conceptions of the universe or the greatest amount of wonder excited by contemplation of it. Rather, it is in the astronomer, who sees in the sun a mass so vast that even into one of his spots our earth might be plunged without

touching its edges; and who by every finer telescope is shown an increased multitude of such suns, many of them far larger.

Hereafter as heretofore, higher faculty and deeper insight will raise rather than lower this sentiment. At present the most powerful and most instructed intellect has neither the knowledge nor the capacity required for symbolizing in thought the totality of things. Occupied with one or other division of Nature, the man of science usually does not know enough of the other divisions even to rudely conceive the extent and complexity of their phenomena; and, supposing him to have adequate knowledge of each, yet he is unable to think of them as a whole. Wider and more complex intellect may hereafter help him to form a vague consciousness of them in their totality. We may say that just as an undeveloped musical faculty, able only to appreciate a simple melody, can not grasp the variously-entangled passages and harmonies of a symphony, which in the minds of composer and conductor are unified into involved musical effects awakening far greater feeling than is possible to the musically uncultured, so, by future more evolved intelligences, the course of things now apprehensible only in parts may be apprehensible all together, with an accompanying feeling as much beyond that of the present cultured man as his feeling is beyond that of the savage.

And this feeling is not likely to be decreased but increased by that analysis of knowledge which, while forcing him to agnosticism, yet continually prompts him to imagine some solution of the Great Enigma which he knows can not be solved. Especially must this be so when he remembers that the very notions, beginning and end, cause and purpose, are relative notions belonging to human thought, which are probably inapplicable to the ultimate reality transcending human thought, and when, though suspecting that explanation is a word without meaning when applied to this ultimate reality, he yet feels compelled to think there must be an explanation.

But, amid the mysteries which become the more mysterious the more they are thought about, there will remain the one absolute certainty, that he is ever in presence of an Infinite and Eternal Energy, from which all things proceed.

THE IGUANODON.

THE iguanodon was discovered by Dr. Mantell, in the Wealden of England, in 1822, and has since figured in geological books as one of the largest and most remarkable of the animals whose former existence is revealed in the fossil beds of past ages. It is described in the second edition of Dana's "Geology" as "an herbivorous dinosaur of the Wealden. It was thirty feet long, and of great bulk, and

had the habit of a hippopotamus. The femur, or thigh-bone, in a large individual, was about thirty-three inches long, and the humerus nineteen inches. The teeth were flat, and had a serrated cutting edge like the teeth of the iguana; and hence the name, signifying *iguana-like teeth;* many of them, from old animals, are worn off short." Le Conte's "Geology" also says that "the animal takes its name from the form of its teeth, which are much like those of the iguana, a living herbivorous reptile, although in other respects there is little affinity." Figs. 1 and 2 show respectively the tooth of an iguanodon, and a section of the jaw of the iguana, for comparison.

FIG. 1.—TOOTH OF AN IGUANODON.

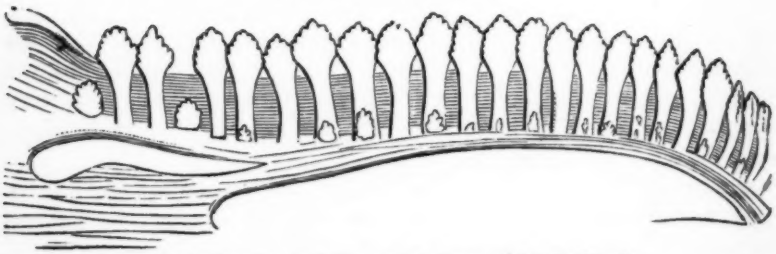

FIG. 2.—SECTION OF JAW OF AN IGUANA. (After Buckland.)

Le Conte adds: "But the difference in size between the living and the extinct reptile is enormous. The iguana is from four to six feet long; the iguanodon was certainly thirty feet, perhaps fifty or sixty feet long, and of bulk several times greater than that of an elephant. A thigh-bone has been found fifty-six inches long, twenty-two inches in circumference at the shaft, and forty-two inches at the condyle. Its habits are supposed to have been something like those of a hippopotamus. Like this animal, it wallowed in the mud, and fed on the rank herbage of marshy grounds." The article "Iguanodon," in the "American Cyclopædia," in the course of its technical description of the bones of the animal that had been identified, suggests that the

thighs "must have supported the heavy body in a manner like that of the large pachyderms," and states that the animal stood higher on its legs than any existing saurian, and was terrestrial in its habits. Dr. Mantell was of the opinion that the iguanodon had a nasal integumental horn. We reproduce in Fig. 3 a picture of the reptile restored, according to the ideas prevailing among geologists ten years ago, in contrast with a view of the actual skeleton set up in the museum at Brussels, as an illustration of the danger of making too hasty generalizations from too few or too imperfectly understood data.

FIG. 3.—IGUANODON.

A new and very considerable deposit of remains of iguanodons, from one of the nearly complete skeletons of which the present reconstruction of the animal has been made, was discovered in 1878 at the coal-mines of Bernissart, between Mons and Tournay, in Belgium, close to the French frontier. They occur there, like the English fossils, in the Wealden or lower cretaceous strata, or *morts-terrains* (dead layers), as the workmen call them, that overlie the coal-beds, and which have to be penetrated for about twelve hundred feet before the coal is reached. The discovery was made by M. Fagès, director-general of the Bernissart Mining Company, and specimens of the bones were sent to Professor P. J. Van Beneden, who identified them as belonging to the iguanodon. The task of removing the fossils was attended with much difficulty, for they were charged with iron pyrites, the decomposition of which caused them to crumble as soon as they were exposed to the air. It was undertaken and accomplished successfully by M. Depauw, superintendent of the workshops of the museum at Brussels. He adopted the habits of the miners, and spent three years in the excavations, personally superintending the removal of every specimen. By subjecting them to a gelatine-bath and enveloping every piece, previous to removal, with a casing of plaster, he got them all out whole. The remains were then again examined by Pro-

fessor Dupont, director of the museum, and again shown to be those of the iguanodon.

For the past two years the bones have been under the steady investigation of M. L. Dollo, a former pupil of Professor Giard, of Lille, who has published four papers giving accounts of his observations, and is expected, when he gets through with his work, to publish an exhaustive treatise on the subject. He thinks he has the skeletons, or parts of them, of twenty-three individuals, two of which belong to Mantell's species (*Iguanodon Mantelli*), and twenty-one to the species *Iguanodon Bernissartensis*. One of the specimens has been restored and mounted by M. Depauw, and set up in a glass chamber in the court of the museum. It is nearly complete, only a few phalanges and other minor details being wanting, while, on account of the impossibility of detaching the bones, most of them have been mounted still joined to one another, and fastened to the matrix as they were taken from the mine. The figure has, of course, for this reason a little stiffness, but not enough to attract the attention of the merely casual observer, and stands, in the natural attitude of progression of the animal on land, erect on its hind-limbs, with the top of its snout fourteen feet two inches from the ground, and covering, from the tip of the tail to a point immediately under the tip of the snout, a length of twenty-three feet nine inches.

The iguanodon belongs to the sub-class of dinosaurians and the order *Ornithopoda*, or bird-footed. Among the special characteristics of the family of the iguanodons are a single row of teeth, three functional digits on the foot, and two symmetrical sternal plates. The last, which Professor Marsh, from his studies of specimens in the British Museum, regarded as clavicles, and traced in them a point of structural resemblance with birds, are declared by M. Dollo, from specimens at Bernissart, in which they are preserved in their natural relations, to be sternal, while no clavicles are found. There are, however, says Mr. H. N. Moseley, in "Nature," abundance of other points in the skeleton of the iguanodon "in which the remarkable resemblances between the *Ornithopoda* and birds indicated by Professor Huxley, more than twelve years ago, are borne out in a most remarkable manner. . . . First of all, there seems to be little doubt possible that the iguanodons walked, as he pointed out, on their hind-limbs erect, like birds, in somewhat the attitude of the accompanying figure (see Fig. 4). Several different lines of coincidence, as M. Dollo points out, tend to prove this. Firstly, the remarkable resemblances between the structure of the pelvis and the posterior limbs of birds, and the corresponding parts in the iguanodons. The points of resemblance of the ilium and ischium, pointed out by Professor Huxley, are fully confirmed by the Bernissart specimens. . . . The actual pubis is very large in the iguanodon, as will be seen in the figure, and projects forward and outward, forming an obtuse angle with the post-

pubis. . . . The post-pubis is long and slender, and directed backward alongside the ischium, as in birds, for a considerable distance beyond the ischial tuberosity. . . . M. Dollo is inclined to follow Professor Marsh in identifying the dinosaurian pubis with the pectineal process of birds, a conclusion which receives most interesting support in the valuable memoir recently published by Miss Alice Johnson, of Cambridge, on "The Development of the Pelvic Girdle in the Chick," in which it is shown that in the embryo fowl the cartilaginous representative of the pectineal process is at first much larger and more prominent in proportion to the dimensions of the pelvis than subsequently, and becomes gradually reduced as development proceeds. The peculiar form of the pelvis is, no doubt, directly connected with the muscular arrangements concerned in the erect posture, originated probably in the dinosaurians and transmitted to birds, in which it has been improved upon by the elimination, almost complete, of the original pubis through disuse."

The fore-limbs are considerably shorter than the hinder ones, and are massive and strong; and this difference in structure is cited as further though not conclusive evidence of the animal's having maintained an erect position. As further evidence in the same direction, and of the approach of the type of structure to that of birds, are mentioned the reduction of the volume of the head and thorax as compared with that of reptiles and the position of a large mass of the viscera behind the hip-joint, as in birds, whereby, with the aid of the long tail, the balancing of the head and fore-part of the body was more easily secured. The dorsal spines of the vertebræ are connected with a set of ossified ligaments binding the whole dorso-lumbar region into a rigid mass—another peculiarity in which the structure is strikingly like that of birds. The fore-limbs of the animal have five and the hind-limbs four claws, or toes, leaving a three-toed track. Here, again, is another and probably the most decisive proof that the iguanodon walked on its hind-limbs only. The feet have been compared by M. Dollo with the tridactyl Wealden foot-prints—which the iguanodon only among known Wealden dinosaurians could have made—and have been found to fit accurately. "If the animal had walked on all-fours," Mr. Moseley remarks, "it is impossible but that pentadactyl impressions should have occurred with the tridactyl, but such is not the case. Long series of the tridactyl prints are found without a trace of pentadactyl marks. The arrangement of the tridactyl tracks shows that the iguanodon walked on its hind-feet, and did not spring, like a kangaroo, with the aid of its tail. This merely dragged lightly behind, and has left no impression in connection with the foot-tracks." The first finger, or thumb, constitutes a large horny spur, the remains of which when first found were supposed to be the nose-horns of Mantell's ideal. According to M. Dollo's description, the head is relatively small, and very much compressed from side to side. The nos-

trils are spacious, and chambered in their anterior region; the orbits are of moderate size and elongated along the vertical. The temporal fossa is limited above and below by a bony arch, a disposition which is otherwise found among living lizards only in the *Hatteria*. The

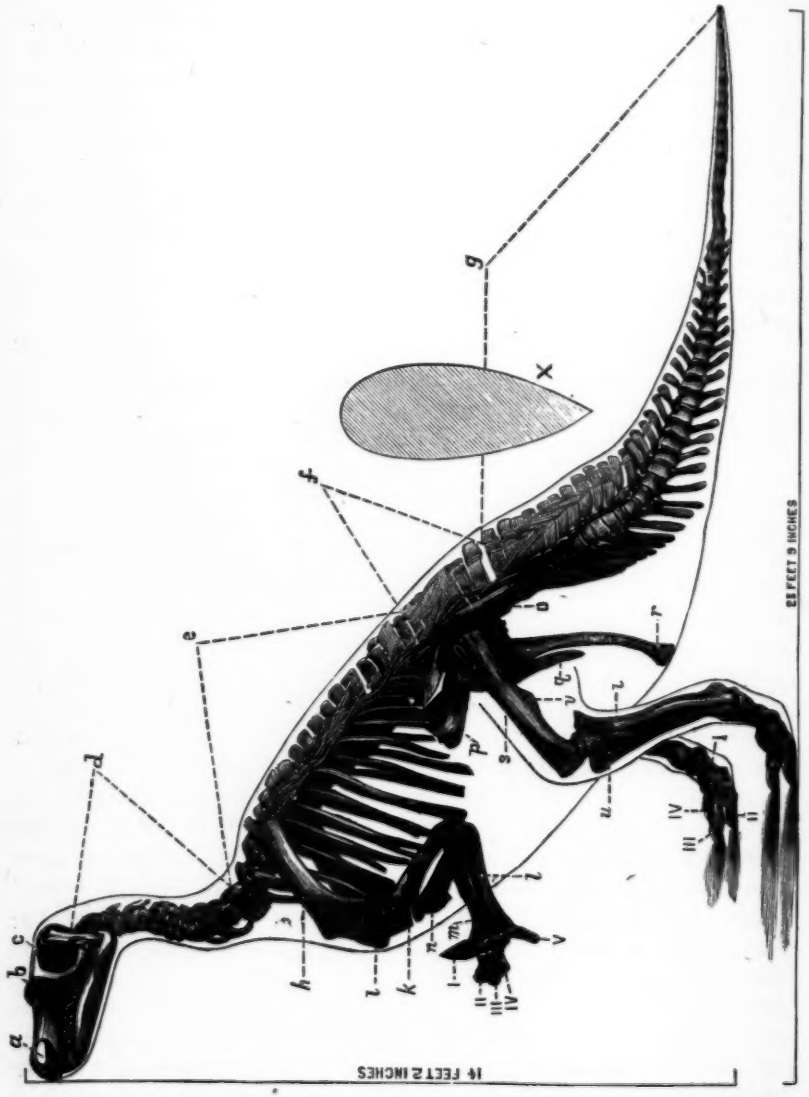

FIG. 4.—IGUANODON BERNISSARTENSIS.—(At the Brussels Royal Museum of Natural History. Restored and mounted by M. L. F. Depauw.)

Head: *a*, left nostril; *b*, left orbit; *c*, left temporal fossa. Vertebral column: *d*, cervical region; *e*, dorso-lumbar region; *f*, sacral region; *g*, caudal region; *h*, left scapula; *i*, left coracoid; *k*, left humerus; *l*, left ulna; *m*, left radius; *n*, sternum; *o*, left ilium; *p*, left pubis; *q*, left post-pubis; *r*, left ischium; *s*, left femur; *t*, left tibia; *u*, left fibula; *v*, third trochanter. I, II, III, IV, V, digits; X, diagrammatic transverse section of the body between the fore and hind limbs.

distal extremities of both jaws are without teeth; while there are ninety-two teeth in the hinder parts of the jaws, and these, as with other reptiles, were replaced by new ones as fast as they wore out. The skin was smooth, or covered only with epidermic scales. Some observers believe they have found in the foot-prints evidences that a slight web existed between the toes. M. Dollo has drawn a conjectural outline of the body of the iguanodon, which is represented in our large cut. Leaving out the long tail, its general shape is that of a duck. The sectional view, represented by X in the cut, indicates that the animal was relatively very narrow and sharp-keeled, like a clipper-ship. The tail, shaped like that of a crocodile, was probably a powerful swimming organ, like that of the duck. The neck was comparatively slender and capable of very free movements. The animal was an inhabitant of marshes—so far as is known, of fresh-water marshes only—and probably fed largely on ferns, abundance of which were found with the Bernissart specimens.

A multitude of other treasures besides the iguanodons were found at Bernissart, and are awaiting careful examination. Among them are crocodiles, in which two new genera have been defined; turtles, which have given one new genus; and "a vast quantity of fishes."

DEFECTIVE EYE-SIGHT.

By SAMUEL YORKE AT LEE.

DETERIORATION of the eye has been, for many years, a topic of complaint—not only in the United States, but in Europe. In Germany, after a careful examination of the pupils in a public school, a surgeon has reported that the proportion of normal-sighted children is gradually less as the ages of the subjects advance: being thirty-six per cent in the primary classes to ninety per cent in the highest classes. Another German investigator reports that, from an examination embracing ten thousand children, it was found that the number of short-sighted in the elementary classes was from five to eleven per cent; in the higher school for girls, the proportion was from ten to twenty-four per cent; in the *Realschulen*, it was between twenty and forty per cent; in the gymnasia, between thirty and fifty per cent; and in the highest classes of all, between thirty-five and eighty-eight per cent. In an examination of six hundred students of theology at Tübingen, it was found that seventy-nine per cent suffered from myopia.

Similar examinations made in the schools of France and of England exhibit similar results, showing that the organ of sight grows weaker as the term of study grows longer. In the United States,

examination proves the same facts. In Philadelphia, a committee of physicians of the Medical Society examined, with the ophthalmoscope, the eyes of four thousand children in the public schools, and their report exhibits similar conclusions. In San Francisco, the Department Superintendent of the Public Schools asserts that, of the pupils who enter the public schools at the eighth grade, and work their way up to the high-school, fully forty per cent are afflicted with one or another form of myopia. Dr. Agnew shows, in a recent report on the progress of near-sightedness in this country, that "our school-rooms are the factors most directly influential in the gradual and increasing development of a race of spectacle-using people." Dr. Derby, Dr. Seguin, and many other scientific philanthropic gentlemen, have uttered similar opinions. Professor Calhoun, of the Atlanta Medical College, says, on this subject, that in the interior of the eye there is an elastic muscle, called the ciliary muscle (circumscribing that aperture through which light is conveyed to the retina), by which the sight is graduated to different distances. In a normal eye, the contractions and expansions of this muscle are not noticed by us; but in a near-sighted or over-sighted eye these changes are violent and sometimes painful; and, eventually, the action of this muscle is spasmodic and so weakened that the sight is permanently injured. Near-sightedness, he remarks, seldom begins until the sixth year, when children commence using the eye on school-books. There are records of the examinations of the eyes of forty-five thousand school-children, of all ages and grades, white and colored, and it has been proved that near-sightedness increases, from class to class, until, in the highest grades, it has actually been developed in as many as sixty or seventy per cent of all the scholars. I saw, lately, in the "Baltimore Sun," that a studious little girl in a public school in that city was struck with blindness at her desk, just after finishing her reading-lesson.

The causes to which this deterioration of eye-sight has been attributed are alleged to be cross-lights from opposite windows, light shining directly on the face, insufficient light, small types, and to the position of the desk, forcing the scholar to bend over and bring the eyes too close to the book or writing-paper, etc.

But, were all these defects remedied, the integrity of the eye would not be restored nor its deterioration prevented. The chief causes of the evil would still remain. These are the colors of the paper and ink. White paper and black ink are ruining the eye-sight of all reading nations. The "rays of the sun," says Lord Bacon, "are reflected by a white body, and are absorbed by a black one." No one dissents from this opinion; but, despite these indications of nature and of philosophy, we print our books and write our letters in direct opposition to the suggestions of optical science.

When we read a book printed in the existing mode, we do not see the letters, which, being black, are non-reflective. The shapes reach

the retina, but they are not received by a spontaneous, direct action of that organ. The white surface of the paper is reflected, but the letters are detected only by a discriminative effort of the optic nerves. This effort annoys the nerves, and, when long continued, exhausts their susceptibility. The human eye can not long sustain the broad glare of a white surface without injury. The author of "Spanish Vistas," in "Harper's Magazine," says of Cartagena that "blind people seem to be numerous there, a fact which may be owing to the excessive dazzle of the sunlight and the absence of verdure." Mr. Seward, in his tour around the world, observed that "in Egypt ophthalmia is universal," attributing it to the same "excessive dazzle" of the wide areas of white sand; and the British soldiers, in the late campaign in that country, exhibited symptoms of the same disease. In the Smithsonian Report for 1877 it is stated, in a paper on "Color-Blindness," that "M. Chevreul has produced 14,420 distinguishable tints of the elementary colors, from which the paper-manufacturers could select colors more agreeable to the eye than the dazzling white, so weakening and lacerating to the nerves of that delicate organ." We know, too, that the Esquimaux, wandering over their snowy plains, and the Arabs, roving over their sandy deserts, are afflicted with inflammation of the eyes, which often results in blindness. I once rode for hours over a Western snow-covered prairie, and experienced the wearisome and irritating glare; and, had my ride been continued longer, I might have found myself in the condition of the gentleman described in the "Cheyenne (Wyoming Territory) Leader," of April 17th ult., as follows: "Ex-Governor John W. Hoyt was brought home in yesterday's coach from the north suffering from snow-blindness. He left Cheyenne on Thursday, and on Friday traveled all day over the snow while the sun shone brightly upon it. The Governor suffered greatly from pain in the eyes in the evening, and at length became totally blind. He has not been able to use his eye-sight since. His physician, Dr. Gray, expresses the belief that the Governor will recover his sight, but must be kept in a dark room for a week." Lieutenant Danenhower, who lost the use of one of his eyes from the reflection of light from ice and snow in the Arctic Expedition of 1881, is a notable illustration of this subject.

From all these authorities and instances it does not seem unreasonable to substitute some other than the universal color of our paper. What color shall it be? Nature and science declare that it should be green. Green grass covers the ground, and green leaves are our canopy, and no color is so grateful to the eye. Plutarch said, in Demosthenes, "it is universally acknowledged that we are not to abandon the unhappy to their sorrows, but to endeavor to console them by rational discourses, or by turning their attention to more agreeable objects—in the same manner as we desire those who have weak eyes to turn them from bright or dazzling colors to green or to others of a softer kind."

And, in his life of Pericles, he says that "green is best suited to the eye by its beauty and agreeableness, and at the same time it refreshes and strengthens the sight." From an old anonymous volume entitled "The Gentleman and Lady instructed," published in London in 1759, I extract the following: "Some authors argue for a providence, from the earth being covered with green rather than with any other color, as being such a right mixture of light and shade that it comforts and strengthens instead of weakening or grieving the eye, and they explain it in this manner: All colors that are more luminous than green overpower and dissipate the animal spirits which are employed in the sight; whereas those that are more obscure do not sufficiently exercise the animal spirits; but the rays which produce in us the idea of green fall upon the eye in such a due proportion that they give the animal spirits their proper play, and, by keeping up the struggle in a just balance, excite a very pleasing and agreeable sensation. But," says the author, "be the cause what it will, we know that its effect is certain." Richerand, the celebrated French physiologist, says, in his chapter on "Sensations": "Green is the softest of colors, the most permanently grateful; that which least fatigues the eyes, and on which they will the longest and most willingly repose. Accordingly, Nature has been profuse of green in the coloring of all plants, and she has, in some sort, dyed of this color the greater part of the surface of the globe." Dr. Thomas Dick, in his work "On the Improvement of Society by the Diffusion of Knowledge," remarks, page 206, section 6: "As the eye is constructed of the most delicate substances, and is one of the most admirable pieces of mechanism connected with our frame, so the Creator has arranged the world in such a manner as to afford it the most varied and delightful gratification. By means of the solar light, which is exactly adapted to the structure of this organ, thousands of objects of diversified beauty and sublimity are presented to the view. It opens before us the mountains, the vales, the woods, the lawns, the brooks and rivers, the fertile plains and flowery fields, adorned with every hue, the expanse of ocean, and the glories of the firmament; and, as the eye would be dazzled were a deep *red* color or a brilliant *white* to be spread over the face of Nature, the Divine Goodness has clothed the heavens with *blue*, and the earth with *green*—the two colors which are the least fatiguing and the most pleasing to the organs of sight; and, at the same time, one of these colors is diversified by a thousand delicate shades, which produce a delightful *variety* on the landscape of the world."

Dr. Phene, in a paper read recently by him before a scientific society in Edinburgh, advised the planting of trees in cities; among the beneficial results of which he mentions "the relief to the optic nerve through the eye resting on objects of a green color, and that, as the power of sight is strengthened and sustained by green glasses, a similar advantage would be gained by the presence of the green foliage in the

streets." And, finally, that profound philosopher, Swedenborg, says in his "True Christian Religion": "What would color be if only white were given and no black? The quality of the intermediate colors, from any other source, is but imperfect. What is sense without relation? and what is relation but things opposite? Is not the sight of the eye darkened by white alone, and enlivened by green, a color inwardly deriving something from black?"

These authorities and facts are entitled to serious consideration. They are all demonstrative of the positive injury, laceration, and destruction of the sight by the reflective dazzle of white; and to what else can we attribute the steadily increasing myopia of the children in our schools? Why not reform it altogether? Let our books be printed on green paper, and let our printers use red, yellow, or white ink for the noxious black. The reform would be revolutionary, and the interests of the trade would be at first hostile to the change. For thousands of years, from papyrus to superfine glittering note-paper, our eyes have been exposed to the deleterious influences of black and white. The change to green, yellow, and red, or to some other agreeable reflective tints, is eventually certain to take place. Science and common sense will compel it. The substitution can not, probably, be sudden nor immediate, for the stationery world must be turned upside down in the process: old school-books, blank-books, and writing-books and inks, must be displaced; and publishers and paper-manufacturers will have to adapt their measures to the new dispensation. But, when it is consummated, everybody will rejoice, except the spectacle-makers. The eyes of the scholar and of the student will no longer be wearied with the myopian contrast of black and white, but strengthened and refreshed by congenial colors; and to pore over the pages of a book would be no more fatiguing to the eyes than gazing on a verdant prairie decorated with variously tinted flowers.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XX.

IN my last I described generally the diffusion of liquids, and the actions to which the names of *endosmosis* and *exosmosis* have been given. It is easily seen that in extracting the juices of meat by immersion in water the work is done by these two agencies. This is the case, whether the extraction is effected by maceration (immersion in cold water) or by stewing.

Some of these juices, as already explained, exist between the fibers of the meat, others are within those fibers or cells, enveloped in the

sheath or cell-membrane. It is evident that the loose or free juices will be extracted by simple diffusion; those enveloped in membranes by exosmosis through the membrane. The result must be the same in both cases: the meat will be permeated by the water, and the surrounding water will be permeated by the juices that originally existed within the meat. As the rate of diffusion—other conditions being equal—is proportionate to the extent of the surfaces of the diverse liquids that are exposed to each other, and, as the rate of osmosis is similarly proportioned to the exposure of membrane, it is evident that the cutting-up of the meat will assist the extraction of its juices by the creation of fresh surfaces; hence the well-known advantage of mincing in the making of beef-tea.

It is interesting to observe the condition of lean meat that has thus been minced and exposed for a few hours to these actions by immersion in cold water. On removing and straining such minced meat it will be found to have lost its color, and if it is now cooked it is insipid, and even nauseous if eaten in any quantity. It has been given to dogs and cats and pigs; these, after eating a little, refuse to take more, and, when supplied with this juiceless meat alone, they languish, become emaciated, and die of starvation if the experiment is continued. Experiments of this kind contributed to the fallacious conclusions described in No. 6 of this series. Although the meat from which the juices are thus completely extracted is quite worthless *alone*, and meat from which they are partially extracted is nearly worthless *alone*, either of them becomes valuable when eaten with the juices. The stewed beef of the Frenchman would deserve the contempt bestowed upon it by the prejudiced Englishman if it were eaten as the Englishman eats his roast beef; but when preceded by a *potage* containing the juices of the beef it is quite as nutritious as if roasted, and more easily digested.

Graham found that increase of temperature increased the rate of diffusion of liquids, and in accordance with this the extraction of the juices of meat is effected more rapidly by warm than by cold water, but there is a limit to this advantage, as will be easily understood by referring back to No. 3, in which are described the conditions of coagulation of one of these juices—viz., the albumen, which at the temperature of 134° Fahr. begins to show signs of losing its fluidity; at 160° becomes a semi-opaque jelly; and at the boiling-point of water is a rather tough solid, which, if kept at this temperature, shrinks, and becomes harder and harder, tougher and tougher, till it attains a consistence comparable to that of horn tempered with gutta-percha.

I have spoken of beef-tea, or *Extractum Carnis* (Liebig's Extract of Meat), as an extreme case of extracting the juices of meat, and must now explain the difference between this and the juices of an ordinary stew. Supposing the juices of the meat to be extracted by maceration in cold water, and the broth thus obtained to be heated in

order to alter its raw flavor, a scum will be seen to rise upon the surface; this is carefully removed in the manufacture of Liebig's extract or the preparation of beef-tea for an invalid, but in thus skimming we remove a highly-nutritious constituent—viz., the albumen which has coagulated during the heating. The pure beef-tea, or Extractum Carnis, contains only the creatine, creatinine, the soluble phosphates, the lactic acid, and other non-coagulable saline constituents, that are rather stimulating than nutritious, and which, properly speaking, are not digested at all—i. e., they are not converted into chyme in the stomach, do not pass through the pylorus into the duodenum, etc., but, instead of this, their dilute solution passes, like the water we drink, directly into the blood by endosmosis through the delicate membrane of that marvelous network of microscopic blood-vessels which is spread over the surface of every one of the myriads of little upstanding filaments which, by their aggregation, constitute the villous or velvet coat of the stomach. In some states of prostration, where the blood is insufficiently supplied with these juices, this endosmosis is like pouring new life into the body, but it is not what is required for the normal sustenance of the healthy body.

For ordinary food, all the nutritious constituents should be retained, either in the meat itself, or in its liquid surrounding. Regarding it theoretically, I should demand the retention of the albumen in the meat, and insist upon its remaining there in the condition of tender semi-solidity, corresponding to the white of an egg when perfectly cooked, as described in No. 4. Also that the gelatine and fibrine be softened by sufficient digestion in hot water, and that the saline juices (those constituting beef-tea) be *partially* extracted. I say "partially," because their complete extraction, as in the case of the macerated mince-meat, would too completely rob the meat of its sapidity. How, then, may these theoretical desiderata be attained?

It is evident from the principles already expounded that cold extraction takes out the albumen, therefore this must be avoided; also that boiling water will harden the albumen to leathery consistence. This may be shown experimentally by subjecting an ordinary beefsteak to the action of boiling water for about half an hour. It will come out in the abominable condition too often obtained by English cooks when they make an attempt at stewing—an unknown art to the majority of them. Such an ill-used morsel defies the efforts of ordinary human jaws, and is curiously curled and distorted. This toughening and curling is a result of the coagulation, hardening, and shrinkage of the albumen, as described in No. 3.

It is evident, therefore, that in stewing, neither cold water nor boiling water should be used, but water at the temperature at which albumen just begins to coagulate—i. e., about 134°, or between this and 160° as the extreme. But here we encounter a serious difficulty. How is the unscientific cook to determine and maintain this tempera-

ture? If you tell her that the water must not boil, she shifts her stew-pan to the side of the fire, where it shall only simmer, and she firmly believes that such simmering water has a lower temperature than water that is boiling violently over the fire. "It stands to reason" that it must be so, and, if the experimental philosopher appeals to fact and the evidence of the thermometer, he is a "theorist."

The French cook escapes this simmering delusion by her common use of the *bain-marie* or "water-bath," as we call it in the laboratory, where it is also largely used for "digesting" at temperatures below 212°. This is simply a vessel immersed in an outer vessel of water. The water in the outer vessel may boil, but that in the inner vessel can not, as its evaporation keeps it below the temperature of the water from which its heat is derived. A carpenter's glue-pot is a very good and compact form of water-bath, and I recommend the introduction of this apparatus into kitchens where a better apparatus is not obtainable. Some iron-mongers keep in stock a form of water-bath which they call a "milk-scalder." This resembles the glue-pot, but has an inner vessel of earthenware, which is, of course, a great improvement upon the carpenter's device, as it may be so easily cleaned.

One of the incidental advantages of the *bain-marie* is that the stewing may be performed in earthenware or even glass vessels, seeing that they are not directly exposed to the fire. Other forms of such double vessels are obtainable at the best iron-mongers'. I have lately seen a very neat apparatus of this kind, called "Dolby's Extractor." This consists of an earthenware vessel that rests on a ledge, and thus hangs in an outer tin-plate vessel; but, instead of water, there is an air-space surrounding the earthenware pot. A top screws over this, and the whole stands in an ordinary saucepan of water. The heat is thus very slowly and steadily communicated through an air-bath, and it makes excellent beef-tea; but, being closed, the evaporation does not keep down the temperature sufficiently to fulfill the above-named conditions for perfect stewing. At temperatures *below the boiling-point* evaporation proceeds superficially, and the rate of evaporation at a given temperature is proportionate to the surface exposed, irrespective of the total quantity of water; therefore, the shallower the inner vessel of the *bain-marie*, and the greater its upper outspread, the lower will be the temperature of its liquid contents when its sides and bottom are heated by boiling water. The water in a basin-shaped inner vessel will have a lower temperature than that in a vessel of similar depth, with upright sides, and exposing an equal water-surface. A good water-bath for stewing may be extemporized by using a common pudding-basin (I mean one with projecting rim, as used for tying down the pudding-cloth), and selecting a saucepan just big enough for this to drop into, and rest upon its rim. Put the meat, etc., to be stewed into the basin, pour hot water over them, and hot water into the saucepan, so that the basin shall be in a water-bath; then let this

outer water simmer—very gently, so as not to jump the basin with its steam. Stew thus for about double the time usually prescribed in English cookery-books, and compare the result with similar materials stewed in boiling or "simmering" water.

XXI.

In my last I explained the hardening effect of boiling water on meat, and the consequent necessity of keeping down the temperature considerably below the boiling-point in order to obtain a tender and full-flavored stew. Some further explanation is necessary, as it is quite possible to obtain what commonly passes for tenderness by a very flagrant violation of the principles there expounded. This is done on a large scale and in extreme degree in the preparation of ordinary Australian tinned meat. A number of tins are filled with the meat, and soldered down close, all but a small pin-hole. They are then placed in a bath charged with a saline substance, such as chloride of zinc, which has a higher boiling-point than water. This is heated up to its boiling-point, and consequently the water which is in the tins with the meat boils vigorously, and a jet of steam mixed with air blows from the pin-hole. When all the air is expelled and the jet is of pure steam only (a difference detected at once by the trained expert), the tin is removed, and a little melted solder skillfully dropped on the hole to seal the tin hermetically. An examination of one of these tins will show this final soldering with—in some—a flap below to prevent any solder from falling in among the meat. The object of this is to exclude all air, for, if only a very small quantity remains, oxidation and putrefaction speedily ensue, as shown by a bulging of the tins instead of the partial collapse that should occur when the steam condenses, the display of which collapse is an indication of good quality of the contents.

By "good quality" I mean good of its kind; but, as everybody knows who has tried beef and mutton thus prepared, it is not satisfactory. The preservation from putrefactive decomposition is perfectly successful, and all the original constituents of the meat are there. It is *apparently* tender, but *practically* tough—i. e., it falls to pieces at a mere touch of the knife, but these fragments offer to the teeth a peculiar resistance to proper masticatory comminution. I may describe their condition as one of pertinacious fibrosity. The fibers separate, but there they are as stubborn fibers still.

This is a very serious matter, for, were it otherwise, the great problem of supplying our dense population with an abundance of cheap animal food would have been solved about twenty years ago. As it is, the plain tinned-meat enterprise has not developed to any important extent beyond affording a variation with salt junk on board ship.

What is the *rationale* of this defect? Beyond the general statement that the meat is "overdone," I have met with no attempt at

explanation; but am not, therefore, disposed to give up the riddle without attempting a solution.

Reverting to what I have already said concerning the action of heat on the constituents of flesh, it is evident that in the first place the long exposure to the boiling-point must harden the albumen. *Syntonin*, or *muscle-fibrine*, the material of the ultimate contractile fibers of the muscle, is coagulated by boiling water, and further hardened by continuous boiling, in the same manner as albumen. Thus, the muscle-fibers themselves and the lubricating liquor* in which they are imbedded must be simultaneously toughened by the method above described, and this explains the pertinacious fibrosity of the result.

But how is the apparent tenderness, the facile separation of the fibers of the same meat, produced? A little further examination of the anatomy and chemistry of muscle will, I think, explain this quite satisfactorily. The ultimate fibers of the muscles are enveloped in a very delicate membrane; a bundle of these is again enveloped in a somewhat stronger membrane (*areolar tissue*); and a number of these bundles or *fasciculi* are further enveloped in a proportionally stronger sheath of similar membrane. All these binding membranes are mainly composed of gelatine, or the substance which (as explained in No. 5) produces gelatine when boiled. The boiling that is necessary to drive out all the air from the tins is sufficient to dissolve this, and effect that easy separability of the muscular fibers, or fasciculi of fibers, that gives to such overcooked meat its fictitious tenderness.

I have entered into these anatomical and chemical details because it is only by understanding them that the difference between true tenderness and spurious tenderness of stewed meat can be soundly understood, especially in this country, where stewed meats are despised because scientific stewing is practically and generally an unknown art. Ask an English cook the difference between boiled beef or mutton and stewed beef or mutton, and in ninety-nine cases out of a hundred her reply will be to the effect that stewed meat is that which has been boiled or simmered for a longer time than the boiled meat.

She proceeds, in accordance with this definition, when making an Irish stew or similar dish, by "simmering" at 212° until, by the coagulation and hardening of the albumen and syntonin, a leathery mass is obtained; then she continues the simmering until the gelatine of the areolar tissue is dissolved, and the toughened fibers separate or become readily separable. Having achieved this disintegration, she supposes the meat to be tender, the fact being that the fibers individually are tougher than they were at the leathery stage. The mischief is not limited to the destruction of the flavor of the meat, but includes the

* I have ventured to ascribe this lubricating function to the albumen which envelops the fibers, though doubtful whether it is quite orthodox to do so. Its identity in composition with the synovial liquor of the joints and the necessity for such lubricant justify this supposition. It may act as a nutrient fluid at the same time.

destruction of the nutritive value of its solid portion by rendering it all indigestible, with the exception of the gelatine which is dissolved in the gravy. This exception should be duly noted, inasmuch as it is the one redeeming feature of such proceeding that renders it fairly well adapted for the cookery of such meat as cow-heels, sheep's trotters, calves'-heads, shins of beef, knuckles of veal, and other viands which consist mainly of membranous, tendinous, or integumentary matter composed of gelatine. To treat the prime parts of good beef or mutton in this manner is to perpetrate a domestic atrocity.

I am not yet able to record the result of stewing a sirloin of beef in accordance with the scientific principles expounded in my last. Have no hopes of being able to do so until I can spare time to stand by the kitchen fire with thermometer in hand from beginning to end of the process, or have constructed a stewing-pot, big enough for the purpose, so arranged that its contents can not possibly by any effort of ingenious perversity be raised above 180°. The domestic superstition concerning simmering is so wide-spread and inveterate that every normally-constituted cook stubbornly believes that simmering water is of much lower temperature than boiling water, and therefore any amount of instruction or injunctions for the maintenance of a heat below boiling will be stubbornly translated into an order for "gentle simmering," a quarter of an hour of which would spoil the sirloin.

I may, however, mention an experiment that I have made lately. I killed a superannuated hen—more than six years old, but otherwise in very good condition. Cooked in the ordinary way she would have been uneatably tough. Instead of being thus cooked, she was gently stewed about four hours. I can not guarantee to the maintenance of the theoretical temperature, having suspicion of *some* simmering. After this she was left in the water until it cooled, and on the following day was roasted in the usual manner, i. e., in a roasting-oven. The result was excellent; as tender as a full-grown chicken roasted in the ordinary way, and of quite equal flavor, in spite of the very good broth obtained by the preliminary stewing. This surprised me. I anticipated the softening of the tendons and ligaments, but supposed that the extraction of the juices would have spoiled the flavor. It must have diluted it, and that so much remained was probably due to the fact that an old fowl is more fully flavored than a young chicken. The usual farmhouse method of cooking old hens is to stew them simply; the rule in the midlands being one hour in the pot for every year of age. The feature of the above experiment was the supplementary roasting. As the laying season is now coming to an end, old hens will soon be a drug in the market, and those among my readers who have not a hen-roost of their own will oblige their poulterers by ordering a hen that is warranted to be four years old or upward. If he deals fairly he will supply a specimen upon which they may repeat

my experiment, very cheaply. It offers the double economy of utilizing a nearly waste product and obtaining chicken-broth and roast fowl simultaneously.

One of the great advantages of stewing is that it affords a means of obtaining a savory and very wholesome dish at a minimum of cost. A small piece of meat may be stewed with a large quantity of vegetables, the juice of the meat savoring the whole. Besides this, it costs far less fuel than roasting.

The wife of the French or Swiss landed proprietor, i. e., the peasant, cooks the family dinner with less than a tenth of the expenditure of fuel used in England for the preparation of an inferior meal. A little charcoal under her *bain-marie* does it all. The economy of time corresponds to the economy of fuel, for the mixture of viands required for the stew once put into the pot is left to itself until dinner-time, or at most an occasional stirring of fresh charcoal into the embers is all that is demanded.—*Knowledge.*

CATCHING COLD.

By C. E. PAGE, M. D.

"She caught her death o' cold, taking gruel out of a damp basin."—*Old Story.*

THERE has always been more or less of mystery connected with the disorder popularly called "a cold." A close observer, in studying this question, will find:

1. That, while persons of all ages, sexes, occupations, social positions, and in all conditions of general health—from the delicate infant and the frail consumptive to the most robust man—have colds, say to-day, from the slightest causes, often enough, indeed, when utterly at a loss to account for the attack; next month, or next week, perhaps, the same individuals—the frail and delicate ones, even—may pass through severe exposures to wet and cold, even to the point of being chilled through and through, without producing a symptom of this disorder.

2. Every day throughout the year we see evidences of the disease; to the last individual in any community none escape altogether, a large proportion are affected several times, and individuals there are who rarely pass an entire month without some of the symptoms; while others, notably children and infants who are fed every hour or two, are almost constant sufferers from nasal catarrh, difficult breathing ("snuffles"), and general *malaise*, and are peculiarly subject to acute attacks.

3. Whenever it happens that an unusually large proportion of the people are attacked at about the same time, the disease is popularly

attributed to the influence of an "influenza-wave"; but this theory seems to me utterly untenable, else a still larger proportion would be thus affected, and the disease would, in general, be confined to such periods; whereas very many escape at such times, only, alas! to fall victims to the disorder during the finest season of the year, when the weather is the mildest and most charming and the temperature most uniform. Indeed, some of the severest "attacks" are observed at such times, and the disease is far more prevalent during a season of steady hot weather in summer than during a period of steady cold weather in winter! But it is during a *warm spell* in midwinter, after the world has for quite a period of intense cold been *confined within-doors*, that "everybody has a cold"!

4. While the disease under consideration is no respecter of persons, but is as universal as the dietetic habits of the people are uniform, there is one class, viz., vegetarians, who are very much less subject to it, often passing the entire year without an attack, or, if attacked, are less seriously affected, and recover more speedily than others about them. Individuals, indeed, there are, living still more abstemiously, and paying proper regard to the ventilation of their dwellings, who *never* have a cold, though half the town may be sick with the disease: the "wave" never touches even the hem of their garments.

5. Members of this class, however, upon resuming their former practices as to diet, returning to the "mixed" diet and three meals a day, also resume the habit of "catching cold"; indeed, a visit of a few weeks, in a family of "good livers," especially if the latter are "air-haters" also, will often produce an attack.

Personally, though a life-long sufferer from the disease in various forms, from the "snuffles" of infancy to the "hay-fever" of adult age, together with occasional attacks of neuralgia, rheumatism, throat and lung affections, etc., I now find it impossible to excite any of the "well-known symptoms," or, in fact, any form of disease, though subjecting myself to what many would consider the most suicidal practices in the matter of exposure to the elements, so long as I live upon a frugal diet, chiefly cereals and fruit, served plainly—nominally two meals a day; holding myself ready, however, to "skip" a meal when necessary, i. e., whenever any of the symptoms of indigestion, as acid stomach, flatulence, pressure in the region of the lungs or stomach, etc., warn me of having carried the pleasures of the table a trifle beyond the needs of the organism.

I have, in my efforts to "catch" cold, submitted myself to exposures that to the minds of most people would appear of a suicidal character, wearing low shoes and walking in snow and slop until both socks and shoes were saturated, sitting an hour in that condition and going to bed without warming my feet; removing flannel under-garments in midwinter on the approach of *colder weather*, and attending to out-door affairs without the overcoat habitually worn; sleeping with

a current of air blowing directly on my head and shoulders; sitting entirely naked in a draught, on a very cold, damp night in the fall, for fifteen minutes before getting into bed; wearing cotton night-shirt and sleeping under light bed-covers on the night following the use of flannel gown and heavy-weight bedclothes; rising from bed on a cold, rainy morning, and sitting naked for an hour, writing, and then putting on shirt and trousers only, the shirt almost saturated with rain and the trousers quite damp, from hanging by the window—these and similar experiments I have tried repeatedly, but without catching cold: I become cold, and become warm again, that is all.*

On the other hand, changing the nature of my experiments, going back to my old habits as to diet—the indulgence of what we call a "generous" diet—the universal mixed diet of the people, viz., fish, flesh, fowl, with the hot, stimulating, and greasy condiments almost invariably associated with this class of food, together with pastry, puddings, and sauces, coffee, etc.—I have found no difficulty in accumulating a "cold," and within a reasonable length of time—the time depending upon the degree of my over-indulgence as to frequency and amount—although, now, a part of the programme consisted in taking the most extreme care to avoid everything in the way of "exposures," as this term is commonly applied—keeping the feet dry and warm, paying the utmost attention to wraps, etc., etc. Indeed, my own experience and observation satisfy me of the truth, and furnish ample explanation for it, of the oft-expressed opinion that those people who wrap the most and take the most care in such respects are the greatest sufferers from "colds"; and, theoretically, this would be the logical deduction from a consideration of the simple facts taught even in the primary text-books on physiology: certainly, the less clothing one wears and the more he is exposed to cold, the nearer he is carried, metaphorically speaking, to the polar regions, where *surfeit-fever* is unknown! Said an observing friend to me, "I am apt to catch cold when I put on my winter flannels—why is it?" My explanation was satisfactory to him, for he was a bright man; but, in general, it is difficult for people to comprehend the fact or the principle involved therein.†

* Accidents often cause worse exposures than any I have enumerated above, without exciting this disorder: for example, upon the occasion of a shipwreck on a bleak, Northern coast, in winter, not one of the stranded mariners or passengers would have "a cold" in consequence. Indeed, a sufficient degree of exposure to hunger and cold would tend to "cure" every case of this disorder that previously existed on shipboard; and if the exposure should not extend beyond measure—beyond the power of endurance of an individual or the entire group—no sickness of any sort would result.

† For the past two winters the writer has worn no under-flannels. He removed them in midwinter (1881–'82) as a part of the treatment for "a cold!" The balance of the curative regimen consisted in a quick sponge-bath, succeeded by an air-bath with friction for fifteen minutes in a cool room, abstaining from food for the entire day, though the appetite was craving, engaging in active exercise in the open air. By night the feverish symptoms had disappeared, the oppressed lungs were relieved, hoarseness scarcely noticeable—in a word, convalescence established.

In the course of my experiments, whenever I have fed my cold as far as I wished or dared to go, I have, in every instance, banished the disease by entirely abstaining from food for a time; I have never known this remedy (if applied at the very onset) to fail of "breaking up" a common cold in twenty-four to forty-eight hours, whatever the age, sex, or occupation of the patient. However we may differ as to the origin of the disorder, whenever I can prevail upon a sufferer to try this remedy, we come to be of one opinion as to what will most surely and speedily "cure" it.

Of course the size of the "dose" must bear some relation to the severity of the case:* On the first appearance of the disease—the symptoms of a slight cold, so familiar to all—skipping a single meal, in the case of a person who takes but two meals a day habitually, or two meals, in the case of a three-mealer, will sometimes suffice, if the succeeding meals be very moderate ones. I have usually, in my experimentation, been satisfied to "turn" at the "one-meal buoy," not often being obliged to abstain longer than twenty-four hours. When, however, I have chosen to prolong the experiment by continuing to eat heartily, as is the custom with people in general at such times, I have found my experience identical with theirs: the symptoms would increase in severity, and to nasal catarrh, headache, slight feverishness, and languor, would be added sore-throat, perhaps, with pressure at the lungs, hoarseness, increased fever, and entire indisposition for exertion. In this case, two, perhaps three days' fasting would be required, with a little extra sponging of the skin, to completely restore the balance. Out-door air is desirable, and—when not demanding too great effort—exercise. *Air-baths*, when there is much feverishness of the skin, are comforting and curative. The practice of *holding down* the bedclothes, in case of fever and delirium, lest the burning body "catch cold," and of stinting the supply of fresh air for the same reason, is no less irrational than to withhold water or to offer food.

Years of study and observation have forced me to the conclusion that the disease which manifests the symptoms popularly supposed to indicate that a cold has been caught is to all intents and purposes a

* In the "Boston Journal of Chemistry," February, 1882, I reported a case of consumption (the patient, seventy years old, had been declining for three years, and was helpless in bed) cured by a forty-three days' fast. He had been a great sufferer; but his cough and pains gradually disappeared during the first two weeks. Within four months thereafter, on a fruit-and-bread diet, he had regained his normal weight and strength.

A bad case of malarial fever, the past summer, yielded to a twelve days' fast, *and nothing else*. Another patient suffering from rheumatism, with night-sweats, fasted thirteen days, obtaining great relief. His night-sweats ceased the fourth day.

Dr. Wood, Professor of Chemistry in Bishop's College, Montreal, reports for the Canada "Medical Record" forty-seven cases of acute articular rheumatism cured by fasting—time required, from four to eight days—and a recent letter assures me that this remedy is still successful with him. He consequently has come to regard rheumatism as "a phase of indigestion."

filth-disease, arises largely from indigestion, and forms the basis, so to say, or is in fact the *first stage of all* the so-called filth-diseases. Whatever interferes with digestion or depuration, or depraves the vital organism in any manner, produces an impure condition of the body—a condition of disease; and a continuance of disease-producing habits must inevitably result in periodical or occasional "eruptions," the severity of which will depend upon the degree of one's transgression. Among the causes of this impure bodily condition are (1) impure food,* (2) excess in diet, and (3) impure air. Our homes, offices, shops, halls, court-houses, churches, and, with rare exceptions, all living-rooms, private or public, are insufficiently or not at all ventilated; and, except while in the open air, a very large proportion of our people, in all the walks of life, habitually breathe an atmosphere vitiated by being breathed over and over again; they are starving for want of oxygen, and are being poisoned by carbonic acid. In default of sufficient oxygen the best of food can not be transformed into pure blood—there will always be a corresponding indigestion; nor can the carbonic acid be eliminated freely in an impure atmosphere. We have, then, serious "interference with digestion and depuration," whenever we remain even for a single hour of the twenty-four in an "in-door" atmosphere, i. e., an atmosphere that is not in tolerably free communication with the great body of air without. The only offset for restriction in oxygen is restriction in diet and exercise; but a combination of this character would produce enfeeblement of the system, though if a proper balance were maintained there would arise no febrile symptoms such as we are considering. We have plenty of people living in unventilated rooms who, so far as *exercise* is concerned, live a well-balanced life; but seldom do these, any more than the robust and active, practice any sort of voluntary restriction as to quality or quantity of food—nausea and lack of appetite being the only safeguards. Persons of this class are great sufferers from colds.

Impure air, although a prevailing source of disease, is not absolutely essential in provoking this disorder; an unwholesome diet alone being sufficient. In none of my own experiments have I suffered any restriction in the matter of pure air. But for this depraved condition —this chronic state of impurity—that I have undertaken to describe

* Under this head I am led to class all foods eaten unnaturally, as (1) farinaceous dishes (the mushes, soft bread, etc.), that on account of their mode of preparation and dressing can not be insalivated; and (2) flesh-food that is "well masticated" or taken in the form of hash. It has been demonstrated (by experiments on dogs) that carnivorous animals fed on hashed meat suffer from indigestion, while, if they are allowed to swallow their meat as they like, in chunks, it is all digested. In repeated experiments upon myself, I find that a moderate ration of meat, swallowed in pieces of convenient size, occasions no disturbance, while the same quantity chewed fine, or taken in the form of hash, is not well borne. The point is, that while minced meat passes out of the stomach before being dissolved by the gastric juice, large pieces remain to be gradually dissolved. There is no demand for the chemical action of saliva on this class of foods.

and account for, such sicknesses as croup, diphtheria, pneumonia, measles, scarlet, typhus, typhoid,* rheumatic, "malarial," and other fevers.

I have already remarked that the condition of disease produced by an unhygienic mode of living, relating chiefly to food and air, and whose occasional ebullitions are observed in the "well-known symptoms of cold," forms the basis of most sicknesses by whatever name they are known. "I catched cold in the first place, and kept adding to it, some way, I couldn't tell how, and finally it settled on my kidneys" (or lungs, throat, face, limbs, or whatever organ or locality seems especially affected). As the nearest to a panacea for all the physical ills of life, I would offer this: Take care of the colds and the fevers will take care of themselves. Whatever may be the origin of disease, or whatever may give rise to its manifestations, whenever these manifestations or symptoms are said to indicate a cold, the condition, as every intelligent physician well knows, is that of *fever:* the thermometer placed under the tongue shows at once that the temperature is above the normal. The patient may, usually does, have periods of chilliness; his first noticeable symptom is, very likely, a chill; and if at such a moment he happens to feel a puff of fresh air on his cheek he thinks *that* was the moment when he caught his cold! Possibly he might have been feeling a little too warm, and that "draught" † did the business for him! Chills and fever, speaking in popular phrase (in reality it is *all* fever), indicate blood-poison, always. In its earliest stage, the patient, being perhaps wholly unaware of his condition, feels "too warm," and throws off coat or shawl; pretty soon he feels the reaction—the chill—and, thinking he has done a careless thing in removing the garment, replaces it; too late, alas! he has already caught cold!

"It is noteworthy as a curious yet easily explicable fact," says the "Lancet," "that few persons take cold who are not either self-consciously careful or fearful of the consequences of exposure."‡ It is

* It is held by some that typhoid fever and some other diseases depend upon the introduction of germs of the disease from without the organism. "No seed, no crop," remarks a friend, and adds: "These germs do not always lodge, or, if they do, may not grow; but they may. Not all the thistle-seeds take root and grow." To which I reply, that neither thistles nor any other undesirable weeds ever "get the start" of a good gardener; and that, of all antagonists to obnoxious or undesirable "weeds," the vital organism, under the influence of rational personal hygiene, is the most alert and efficient. —none of these, or at least but seldom, could get a foothold.

† Whenever a patient comes to me with "a cold," complaining of a draught, I usually ask, "A 'draught' of what—pure air or impure food?" The answer, in the absence of certain physiological knowledge, is sure to be a blank stare of helpless ignorance as to my meaning.

‡ Former patients comfort me with such remarks as these: "Your colds-theory has given me a new lease of life;" "How thankful I am for being rid of my old fear of cold air!" "I date my first real improvement from the hour when you induced me to throw off my dread of cold," etc. "Now that I know what it is," writes a bright Southern lady,

not, however, that these over-careful people catch cold from fear, but rather that their cowardice keeps them in-doors too much, or incites them to "muffling" themselves when they do go out—they quake from fear of "night-air," "draughts," and so cheat themselves of health-producing influences. Lacking active exercise and fresh air, or sweltering with an excess of clothing, they must suffer from indigestion. That is, though they may *eat* as much, or more, they can not *digest* as much as the fearless person who dresses light, pays no heed to the weather, spends considerable time out-doors every day, and, because of this, can not and will not remain in "stuffy" rooms.

The "fresh-air idiot" seldom takes cold. "That may be," says the timid, blood-poisoned, chilly man, "but he causes every one else to, with the open doors and windows." There is a grain of truth, if not of sense, in this assertion; for the pure air in contact with the skin, and in the lungs, of those who are most in need of it—who are filled up, so to say, with the impurities of indigestion and deficient depuration—the constipated air-haters—gives the needed stimulus, or, rather, so augments the vital powers that "the reconstructive process is initiated, and thus apparently the disease itself, but there is a wide difference between a proximate and an original cause. A man may be too *tired* to sleep and too *weak* to be sick. Bleeding, for the time being, may 'break up' an inflammatory disease—the system has to regain some little strength before it can resume the work of reconstruction. The vital energy of a person breathing the stagnant air of an unventilated stove-room is often inadequate to the task of undertaking a restorative process—though the respiratory organs, clogged with phlegm and all kinds of impurities, may be sadly in need of relief. But, during a sleigh-ride, or a few hours' sleep before a window left open by accident, the bracing influence of the fresh air revives the drooping vitality, and Nature avails herself of the chance to begin repairs—the lungs reveal their diseased condition, i. e., they proceed to rid themselves of the accumulated impurities.

"For," continues Oswald,* "rightly interpreted, the external symptoms of disease constitute a restorative process that can not be brought to a satisfactory issue till the cause of the evil is removed. So that, in fact, the air-hater confounds the cause of his *recovery* with the cause of his *disease*. Benjamin Franklin, "whose wisdom was of that rare kind which does not grow old," expressed his conviction of the fact that "the causes of 'colds' are totally independent of wet and even of cold."† Dr. Herring remarks of a family of friends, "They all invariably had 'colds in the head' the next day after dining on roast goose!"

"I seldom catch cold, and, when I do, it gets away again right soon!" I am compelled to admit that all this is more profitable for patients than for the practitioner.

* "Physical Education," by F. L. Oswald, M. D.; New York, D. Appleton & Co.

† "Essays," p. 216.

"The immediate effects of a displacement of blood from the surface, and its determination to the internal organs, are not," says the "Lancet," "as was once supposed, sufficient to produce the sort of congestion that issues in inflammations. If it were so, an inflammatory condition would be the common characteristic of our bodily state. When the vascular system is healthy, and that part of the nervous apparatus by which the caliber of the vessels is controlled performs its proper functions normally, any disturbance of equilibrium in the circulatory system which may have been produced by external cold will be quickly adjusted. Most of the sensations of cold or heat," continues the "Lancet," "which are experienced by the hypersensitive have no external cause." They have, however, an internal cause which I have endeavored to point out and account for, as well as indicate the natural remedy. A "chilly" person is a sick person, and is in a state predisposing him to an "attack"—a natural kill-or-cure sickness—whenever external conditions are favorable. But no amount of transient cold, or wet, or draughts, can *alone* originate the symptoms of "a cold"; the predisposing cause must of necessity exist, or the effects will be of a wholly different character: temporary discomfort—suffering, perhaps—and, at the worst (if the exposure be of a severe nature, as in the case of a feeble person), a lowering of the general health. Short of the point of freezing to death, or of exposure so severe as to render reaction impossible, the person will get cold and—get warm again, that is all.

There is a maxim worthy of all acceptation: "If you stuff a cold you will have to starve a fever." Unfortunately abbreviated to "stuff a cold and starve a fever," and utterly misinterpreted, a deal of mischief has been done, for which the only compensation evident to my mind is this: those who have accepted the first division of the command have gorged themselves *conscientiously!* They have taken allopathic doses of a homœopathic remedy—*similia similibus curantur*—with a vengeance! But when the incipient fever became well established did these superobedient children of Nature obey the second injunction? No, and with good reason, apparently—the first prescription proving a failure (?), they did not dare to try the second! Now and then, however, it has been tried, either because of the courage or exceptional intelligence on the part of the patient or his physician, and with uniform good results. Where the "fasting-cure" is applied *in extenso*, with appropriate water and air baths, sunshine, and perfect ventilation, the worst forms of fever rarely have a "run" of ten days—three or four days will often suffice to insure convalescence; whereas, under the milk-and-brandy, beef-tea, and tonic treatment, and "eating little and often," the flames are fed until the patients are *burned to skeletons*, and a large percentage fatally.

I think I should be justified, in the estimation of most people, in saying that mankind are by nature, or at least from custom, if not

gourmands, certainly prone to over-indulgence in diet. I find, in conversing with rational people—and most people are rational to this degree—that they are quite willing to subscribe to this much: "Without doubt we eat too much, and indulge in many dishes of an unwholesome nature." There are, to be sure, many persons who call themselves small eaters, and who do, in fact, eat very little food; such would be inclined to take issue, and upon apparently good grounds, with the assertion that *their* colds could spring from overeating. But we must bear in mind that "excess in diet" is a relative phrase; the quantity of food, if we regard a physiological diet, must be proportioned to—1. The amount of labor performed, or exercise taken; 2. The degree of cold endured; 3. The amount of oxygen taken into the blood; i. e., the purity of the air habitually breathed, since all these circumstances affect the needs of the organism for nutriment, and therefore the amount of the digestive fluids that can possibly be secreted from the blood by the appropriate glands of the stomach, liver, pancreas, and intestines. Moreover, it must relate to the present physical condition of the individual: for example, the man who has recently been purified by a "cold," may carry off, without experiencing serious indisposition, a dinner of a dozen courses (*curses*, as Dr. Abernethy used to call them), either one of which would alone suffice to produce a violent "attack" of indigestion in the case of his neighbor who might be approaching, or already standing on, the "deadline"; but a succession of such indulgences, or continuance of the prevailing mode of living, will ere long again bring him to the end of his tether, so to say—to the brink of the surfeit-precipice upon which so many habitually live—to that condition of the system wherein a single dish of the most wholesome food constitutes an excess. In such a case the form of the disorder will depend upon various circumstances, as the constitution, temperament, or "diathesis" of the individual, the kind of food eaten, amount, etc.—headache, nausea, colic "cramps," or cholera-morbus (in the South, during the heated term, genuine cholera or yellow fever); or it may excite the symptoms of that *initial fever* popularly called a cold. Many people eat little, simply because it is physically impossible for them to eat much. Nausea or lack of appetite prevents them, not from overeating, but from eating a large amount. Such people habitually overeat. Even the small quantity swallowed, in face of Nature's protest, lack of relish, is relatively a greater excess than the huge dinner eaten by a "good feeder" when in condition. Hence, their frequent efforts to eat (every five or six hours, or oftener), especially in view of the kind of food necessary to "tempt the appetite," prevent a ready return to a normal condition—prohibit a natural appetite, i. e., a relish for plain food. For all such patients I would direct, first, a rest for the stomach (and thus a respite for all the viscera concerned in digestion, and relief for the excretories as well), and then attention to the due nutrition of the body, not the tickling of the

palate merely or mainly. "Fasting, fresh air, and exercise, is Nature's panacea," says Dr. Oswald; and so, in practice, I have found it for a wide range of "diseases" that nothing else can reach. If we agree that *disease* results, mainly, from the breathing of impure air, the use of unnatural food or excess, and often deficient exercise, then it would seem to follow that *ease* must depend upon a reform in these particulars. In all my experience with sick people I have never known of the restoration of a single patient to fairly robust health in the absence of such reform. I have rarely known a person to become sick except as the direct result of some degree of fear of pure air, and fearlessness regarding the influence of impure food. Whatever else may have contributed to the production of his disease, it is seldom, indeed, that these may not be truly regarded as the principal causes. Nature's preventive and curative agents may be summed up thus: Pure air, appropriate food, exercise (active or passive as the case may require), skin-cleanliness, with proper ventilation of the surface of the body, i. e., through the use of non-sweltering garments, supplemented by rational exposure of the entire surface of the body to the air, by means of air-baths, sunshine in the home and "sunshine in the heart"—with these, and only these, all curable cases will go on to certain recovery. Without them no medication will avail.

THE SOURCE OF MUSCULAR ENERGY.

By J. M. STILLMAN, Ph. B.

NEW and valuable scientific discoveries and inventions are not slow at the present time in making their way from the closets and laboratories of the investigators or discoverers to popular recognition. It is somewhat otherwise with the gradual development of knowledge on subjects once thought to have been tolerably clearly understood and of no immediate practical value. The gradual modifications which take place in generally accepted theories by the slowly accumulating results of the labor of many investigators are, to be sure, appreciated by the special student in the particular department of knowledge concerned, but are slower in meeting with public recognition. It thus happens that teachers and books, not dealing as a specialty with the subject involved, often adopt and repeat as authoritative views and theories which, by the specialists in those branches, have either been abandoned or brought seriously into question. Nor is it to be otherwise expected. Chroniclers are quick to seize upon and distribute the news of brilliant or startling discoveries or inventions, but those are fewer who will track patiently the slowly accumulating evidence of many workers, appreciate the bearing of their work, and produce it in a

form in which it can be appreciated by those non-specialists most interested in the subject involved.

It is thus, to a certain extent, with the subject of the source of muscular power in the animal organism. It is needless to specify in this particular. Text-books and popular articles touching on the subject are continually asserting, as apparently unquestioned, theories which at the present time are either exploded or very much in doubt. It would seem, therefore, not without value to attempt, as far as practicable in a popular or semi-popular article, a general statement of the present condition of the theories on the source of muscular power, and of the main points of the evidence which tends to support these theories.

The general acceptance of the law of the conservation and correlation of physical forces had at once an important influence in directing attention to the source of muscular force. The idea was readily taken up that this form of force is at the expense of heat, which is produced by the oxidation of carbon and hydrogen in the body, the necessary oxygen being conveyed by the arterial blood to the muscular tissue. In other words, the somewhat trite comparison of the human body and the muscular system to an engine, which consumes just so much fuel to produce so much force, has pretty clearly formulated the idea as generally accepted. And so far as it goes the comparison is not bad.

When, however, we pass beyond this somewhat vague simile to an examination of the more intimate nature of these various processes, we find the questions raised are not so generally understood. Accepting that the muscular force is produced by the ultimate oxidation of carbon and hydrogen to carbonic-acid gas and water respectively, the next questions that suggest themselves are: "What is the immediate source of this carbon and hydrogen—the fuel material for muscular force?" and "What is the real nature of these processes which we call briefly oxidation?" The endeavors to answer these questions have given rise to many discussions and disputes, which are, even at the present day, by no means concluded.

Before taking up the discussion of the theories advanced to answer these questions, it will not be out of place to review very briefly the composition of the muscles and their general relations to the circulation—only in so far, however, as is necessary for a clear comprehension of the evidence and arguments involved in the discussion.

A muscle is essentially a collection of lengthened cells held together by a connective tissue. Each cell consists of a delicate cell-wall or membrane containing a fluid or semi-fluid mass of living (protoplasmic) matter. This gelatinous substance possesses the power of contraction under the stimulus of excitations of various kinds—nervous impulse, electricity, heat—and the cell becomes thereby shortened. This process, taking place simultaneously in all the cells of a given muscle

under the influence of the same exciting cause, is what exerts the power of the contracting muscle. The intensity of this shortening or contracting power has been approximately measured—e. g., by ascertaining experimentally the weight necessary to prevent a muscle from contracting under excitation.* The muscles are supplied with blood by the fine ramifications of the arteries, and the blood is conducted away again by the ramifications of the veins, the arterial blood losing oxygen and taking up carbonic acid during its passage, as is the case in the other tissues also.

Regarding the composition of the muscular tissue, it may be simply noted that the tissue itself is composed mainly of albuminoid material (cell-contents) and of the substance of the connective tissue, which is, like the albuminoids, composed mainly of carbon, hydrogen, oxygen, and nitrogen, and in much the same proportions. Besides this, the blood and lymph permeate the muscular tissue throughout, and certain non-nitrogenous substances, mainly glycogen, a substance resembling starch or dextrine in composition and properties, are stored up in the muscular tissue, and always found to be present. Certain other simple compounds containing nitrogen are also present, and are considered to be decomposition products of the more complex albuminoids. When the muscular contraction takes place, mechanical force may be exerted which is produced at the expense of the force stored up as potential chemical energy in the materials which serve as the fuel material. This potential energy is set free or rendered active by the chemical processes which there take place, and appears as work, as sensible heat, or as electrical disturbances.

Before we inquire as to the nature of these chemical processes, it will be of advantage to glance briefly at the results of important investigations which have been made on this subject, as these form the only safe data by which we may judge of the tenability of any theory. It would be out of place here to attempt a full reference to the mass of investigations and experiments which have been published, and which bear on the topic under discussion.† We shall therefore simply notice the principal facts which have been established as the results of those investigations, and which are most pertinent to the matter in hand.

The experimental researches on this subject may be classified under four heads: 1. The examination of the muscular tissue itself before

* This value has been found in man at about 6,000 to 8,000 grammes per square centimetre of cross-section of muscle (85 to 114 pounds per square inch) for the maximum for voluntary contraction. It is of course evident that the intensity of the force exerted varies with the kind and degree of excitation, so that too much dependence must not be placed on any particular values thus obtained. They simply give an approximate value for ordinary muscular activity.

† Quite full references may be found in the excellent and quite recent text-books of F. Hoppe-Seyler, "Physiologische Chemie," and of A. Gamgee, "Physiological Chemistry of the Animal Body."

and after muscular action. 2. The examination and comparison of the blood coming to the muscle, and that leaving it, during rest and exertion. 3. The examination of the gases given off or absorbed by the active muscle after excision from the animal, and under the influence of artificial irritation. 4. The influence of continuous muscular exertion on the respired gases and on the waste products of excretion.

1. With regard to the changes in the muscular tissue, it has been noticed that the proportion of water in the muscles is increased or the proportion of solids diminished by work, the amount of substances soluble in water is diminished and the amount soluble in alcohol increased; and particularly that glycogen disappears and sugar is increased (the latter probably as a product of fermentation at the expense of the glycogen).

2. Changes produced in the blood are for the most part difficult to trace with certainty; but, it has been observed that the blood coming from the active muscle contains more carbonic acid and less oxygen than that coming from the resting muscle; and, further, that the carbonic acid is increased in greater proportion than the oxygen is diminished. We shall recur to this later.

3. Investigations into the changes which occur in gaseous atmospheres surrounding an excised muscle made to contract under the influence of electricity are interesting and instructive. G. Liebig found that the excised muscle gave off carbonic acid and took up oxygen, but that muscular contraction took place also when the surrounding atmos phere contained no oxygen, carbonic acid being given off, however, in this latter case also. Later observers confirmed these observations, and Matteucci considered, from his experiments in the same direction, that the carbonic acid was not produced at the expense of the oxygen of the surrounding atmosphere, but from oxygen held in some form of combination in the muscular tissue itself. Herrmann found that a portion even of the oxygen absorbed from the air was absorbed in consequence of incipient putrefactions.

4. Investigations under the fourth head, as to the effect of muscular exertion on the general relations of respiration and excretion, have been very elaborate and very numerous. Pettenkofer and Voit, Ludwig and Sczelkow, and others, have investigated the relations of carbonic acid and water given off to food and oxygen consumed as influenced by muscular exertion. Their investigations have shown that the oxygen consumed and carbonic acid and water given off are largely increased by muscular exertion. This had been noticed as a general fact by Lavoisier a half-century or so earlier, but the experiments of the above-named investigators were carried on with a care and thoroughness which left little to be wished for in that direction.

Whether the subject of the experiment be kept on a constant diet during both work and repose, or whether it be allowed to eat and drink according to desire, or even if no food be permitted during the experi-

ment, the general fact remains the same, that the quantities of carbonic acid and water eliminated during work are much greater than during rest, in many cases the ratio being as high as two to one. It is also found that the oxygen taken up, though increased during muscular exercise, is not increased in proportion to the carbonic acid eliminated. The result is, that the ratio of the volume of oxygen consumed to the volume of carbonic acid eliminated, which is normally somewhat less than unity, tends to approach unity during muscular work. It should be here remarked that investigations dealing with total respired gases, although doubtless in the main reliable, are not without certain defects. If we could be certain that muscular exercise left all other organic functions unaffected, we could safely attribute the observed changes to the muscular contraction alone. But such is probably not the case. The functions of organs are influenced by the activity of others, and hence the changes noticed in products of elimination or in the consumption of oxygen can not with safety be attributed solely to the muscular work performed, as these substances are consumed or produced by the combined activity of all the living tissues of the organism. Hence the value of the corroborative testimony of the other methods of investigation noticed above.

The influence of muscular exertion on the elimination of nitrogen has also received much attention, inasmuch as the nitrogen eliminated (mainly in the form of urea by the kidneys) may be taken as a measure of the amount of nitrogenous food or tissue decomposed in the organism. The influence, then, of muscular exertion on the excretion of nitrogen is of importance as showing also its influence on the decomposition of albuminoids (foods or tissues). The results of the numerous investigations on this subject have been somewhat at variance. Many have found no material increase in the elimination of nitrogen during muscular exertion; others find a slight increase, but not sufficient to indicate any immediate relation of the nitrogen eliminated to the work performed. Passing over the work of earlier investigators, we will consider briefly the results of some of the later investigators. Voit was one of the first to make careful and exact experiments extending over a considerable period of time, and he determined that the increase in elimination of nitrogen during muscular exertion is very slight; *that it bears no constant relation to the work done*, and is more influenced by diet than by work. Fick and Wislicenus made an ascent of the Faulhorn in the Alps, with the purpose of determining the possibility or impossibility of albuminoids being the fuel-material for muscular power. They estimated the mechanical work necessary to raise their own bodies through the vertical distance to which they ascended. They then calculated the amount of albuminoids necessary to produce so much force by its combustion. They determined experimentally the amount of nitrogen in their excreta during the period of the ascent, and, having taken no nitrogenous food during that period,

they were enabled to estimate what relation the albuminoid decomposition bore to the amount necessary to supply the power for the ascent. By this method they demonstrated that the whole amount of albuminoid material decomposed during the ascent, even if completely oxidized to carbonic acid, water, and nitrogen (instead of yielding its nitrogen in the form of urea, as is actually the case), would produce less than half the force necessary to raise their bodies through the vertical height to which they ascended. Thus it is shown that the amount of force represented by the actual decomposition of albuminoids during work is by no means adequate to account for the work done, even supposing that all the nitrogenous material decomposed in the body went for that purpose, and that no other muscular work were performed during the ascent than the mere lifting of such a weight to the given height. Both these suppositions are evidently incorrect, as the nitrogen is eliminated in almost equal quantities when no voluntary muscular action is exerted, and the muscular work, voluntary and involuntary (lungs, heart, etc.), on such a trip, would evidently far exceed that necessary for the simple elevation of a dead weight to a specified height.

Experiments conducted by Dr. Parkes on two soldiers proved that a small increase of nitrogen elimination was produced, and also, that this increased elimination of nitrogen may extend for many days after the exercise has ceased.

Dr. Austin Flint, Jr., in an elaborate and thorough investigation on the pedestrian Weston, found a decided increase in the nitrogen eliminated during work; also, a decided increase in the ratio of nitrogen eliminated to that taken in with the food. The value of his results is somewhat impaired for our present purpose, in so far as they relate to the influence of muscular exertion simply, because the condition of the subject during the working period was not such as was favorable for a fair test. His appetite fell off; he slept poorly; was extremely nervous and irritable much of the time; became at times much exhausted and prostrated even to nausea. When the influence of the nervous state and of an exhausted condition on the functions is taken into account, it will be evident that deductions as to the effect of muscular exertion alone would in this instance be open to doubt. Dr. Pavy's experiments on the same pedestrian indicated also an increase in the nitrogen elimination, but only a slight increase as compared with Dr. Flint's results.

What, then, seems tolerably certain is, that muscular exertion increases the nitrogen elimination but slightly, and perhaps only very slightly, so long as the muscular system is *moderately exercised* and not *overtaxed*. And, indeed, the pertinent question here would seem to be, "Is the normal muscular action accompanied with any elimination of nitrogen showing a decided relation of the work done to the nitrogen eliminated?" and not "Is the excessive and exhaustive exertion of the muscles accompanied with any increase of nitrogen elimination?"

Having thus glanced at some of the more important experimental results bearing on this subject, let us return to the consideration of the two questions previously enunciated. First, then, "What is the fuel-material for muscular force? is it albuminoid and nitrogenous, or is it non-nitrogenous?" That it is not essentially nitrogenous will appear from the experiments last described, for if such were the case we should find nitrogen eliminated in much greater quantities during muscular work than during rest, which is not the case. The material which supplies the force by its decomposition must, then, be mainly non-nitrogenous. Here, again, are various possibilities. Fats, sugars, glycogen, are all non-nitrogenous, and we have next to inquire whether the fuel-material be fats, sugars, or glycogen. The facts above stated of the constant occurrence of glycogen in the muscular tissues, and its disappearance in part during muscular exercise, suggest at once the possibility of this substance being a fuel-material. We shall obtain light on this question from the facts regarding the influence of muscular exertion on the ratio of the volume of carbonic acid expired to that of the oxygen taken up. The three principal classes of foods consumed in the animal body are the fats, carbohydrates (starch, sugars, glycogen, etc.), and nitrogenous substances. For the present purpose it may be considered that the fats and carbohydrates are ultimately converted into carbonic acid and water, and that the nitrogenous substances are ultimately converted into carbonic acid, water, and urea. The nitrogenous foods are usually subdivided into albuminoids proper, and substances not albuminoids. All these nitrogenous substances are composed mainly of carbon, hydrogen, oxygen, and nitrogen, and usually also sulphur, in proportions which vary with different substances, but within very narrow limits. For the sake of simplicity, therefore, it will be permissible to take a certain average composition to represent the entire class, and the deductions will apply with sufficient accuracy to the nitrogenous foods as a body. For the sake of easy comparison we may also represent this average composition by a formula which may be considered as representative of the class; e. g., $C_{143}H_{220}N_{38}O_{46}S$. If we now consider this to be oxidized to carbonic acid, water, and urea (and the sulphur to be oxidized to SO_3, as would be the case in the formation of a sulphate), we might represent the process by the following equation:

$$\underset{\text{Albuminoids, etc.}}{C_{143}H_{220}N_{38}O_{46}S} + 299O = 124CO_2 + 75H_2O + 19\underset{\text{Urea.}}{CON_2H_4} + SO_3.$$

This would give 248 volumes CO_2 produced for 299 volumes of oxygen taken up, or a ratio of $\frac{248}{299} = 0{\cdot}83$.

If we consider the fats, and take stearine as a fair example of this class, we should have for such an equation—

$$\underset{\text{Stearine.}}{C_{57}H_{110}O_6} + 163O = 57CO_2 + 55H_2O.$$

or the ratio of volumes of carbonic acid and oxygen would be $\frac{114}{163}$

= 0·70. Other natural fats would give results differing little from this ratio.

The carbohydrates, on the other hand, contain relatively more oxygen than the other classes of foods, and contain hydrogen and oxygen in just such proportions as exist in water. Hence by their oxidation just enough oxygen must be consumed to convert the carbon to carbonic-acid gas, e. g.:

$$\underset{\text{Glycogen.}}{C_6H_{10}O_5} + 12O = 6CO_2 + 5H_2O.$$

$$\underset{\text{Grape-sugar.}}{C_6H_{12}O_6} + 12O = 6C_2O + 5H_2O.$$

The ratio is hence 1 for all this class, since the carbonic acid formed is equal to the volume of the additional oxygen consumed. It follows, then, that the oxidation in the organism of carbohydrates would tend to cause the ratio $\frac{CO_2}{O_2}$ to approach unity. The extensive investigations of Regnault and Reiset on small animals have shown that with carbohydrate food the ratio does approach unity, sometimes almost attaining it, though of course it is impossible to eliminate entirely the decomposition of fats and albuminoids in the organism, and hence the ratio is kept below that figure.

So, also, as we have seen above, the tendency of muscular exertion is to increase this ratio and cause it to approach unity. The evidence, then, seems to point with tolerable conclusiveness to the fact that the *immediate* fuel-material is mainly non-nitrogenous and carbohydrate in its character.* To what extent this supply of carbohydrates is derived from the glycogen of the muscles, to what extent from sugars absorbed from digestion, or produced from the glycogen of the liver, is not yet established with sufficient accuracy, though the participation of the muscle-glycogen is hard to doubt.

We have said the *immediate* fuel-material is apparently carbohydrates, for the possibility still remains that this carbohydrate material may itself be in part derived from albuminoids. It is certain that the liver-glycogen is in great part, possibly entirely, derived from albuminoids. Parke's experiments, above mentioned, showing a continuous elimination of increased quantities of nitrogen in the form of urea

* It will, I think, be evident that the widely entertained theory of Herrmann, regarding the chemical processes taking place during muscular action, is not contradicted by the considerations here advanced. According to this theory, a complex nitrogenous substance of the muscular tissue is decomposed during muscular activity with evolution of carbonic acid, and other non-nitrogenous residues, together with a simpler nitrogenous substance which is supposed again to unite with other (non-nitrogenous) matter to form the original compound, which may be again decomposed during contraction. This still leaves the non-nitrogenous matter the fuel-material, but assumes it to be stored up in the form of a combination with a complex nitrogenous substance which then yields it again in the form of carbonic acid and water. This theory lies too far in the field of speculation for its discussion to come within the scope of the present article.

for days after continued muscular exertion, would be in harmony with such an origin, as they might indicate a gradual replacement of glycogen consumed, at the expense of albuminoid material with elimination of urea as a a waste product. Sugars (grape-sugar and maltose) absorbed from digestion or formed from liver-glycogen, are doubtless consumed in the tissues and organs and assist in producing animal heat. Whether muscular tissue consumes these sugars in greater quantity than other tissues it is difficult to say with certainty.

We come now to the second question as to the nature of this decomposition to which we have alluded as oxidation. This question is still contested. The older theory is that the oxygen, taken up by the blood, is given up in the form of active oxygen, or ozone, and by its energetic oxidizing power burns up or oxidizes the carbon and hydrogen of the fuel-material, with formation of carbonic acid and water.

The newer theory is that the decomposition processes are essentially fermentative in their character; that under the influence of appropriate ferments the substances combine with water, splitting up into simpler and simpler products with evolution of heat or force, as is the case with all fermentative changes. The oxygen present in the arterial blood gives these processes the character of fermentative changes in the presence of oxygen; secondary oxidation takes place, as in putrefaction in presence of air, the final products being mainly carbonic acid and water, as also is the case in putrefactive processes.

Some of the objections raised to the older theory are that we know of no similar changes produced by ozone in watery solutions, such as exist in the animal organism; that the oxygen obtained from the arterial blood under the air-pump contains no ozone. Also certain compounds are found in the blood and tissues which are essentially deoxidized products, which could not be supposed to exist in the presence of ozone, but the presence of which accords with the supposed fermentative character of the processes (Hoppe-Seyler). The fact that the evolution of carbonic acid from the contracting muscle is in great part independent of the presence of oxygen at the time would harmonize also with such a fermentative character of the changes, as carbonic acid is the product of many fermentative changes out of the presence of oxygen, as, for example, of the alcoholic fermentation of sugar. Matteucci's supposed storing up of oxygen in some form of combination in the tissues would then be interpreted rather as the storing up of fermentable substances (like glycogen) rich in oxygen. The combustion theory, on the other hand, would seem to demand that the evolution of carbonic acid and consumption of oxygen should be simultaneous, which is apparently contradicted by the experiments of G. Liebig, Matteucci, and others above mentioned. It would exceed our limits to enter more fully into a discussion of these two opposing theories. The conflict between them is still in progress, and new evidence is constantly accumulating. Both theories agree in this, that

the material which by its decomposition produces the force for muscular work is finally decomposed, with evolution mainly of carbonic acid and water. They differ in their views of the nature of the process and the steps by which these ultimate products are obtained.

We have here endeavored to show briefly what has been gained in comparatively recent times by the growth of knowledge in regard to the source of muscular power. Let us attempt a brief summary of the main points brought forward in the preceding discussion: 1. The source of muscular energy is in the chemical decomposition of certain substances, which is accompanied with a release of energy. 2. The muscular contraction produces a greatly increased production of carbonic acid and water, and an increased consumption of oxygen, in the general respiration. To what extent this is due to the mere muscular contraction, to what extent to the influence of muscular exercise on other functions, is difficult to estimate with certainty. 3. The excised muscle, when caused to contract, gives off carbonic acid, and this action is in great part independent of a simultaneous absorption of oxygen. 4. The blood coming from the contracting muscle contains more carbonic acid and less oxygen than that coming from the resting muscle, and less oxygen than that coming to the contracting muscle. 5. The ratio of carbonic acid given off to oxygen taken up is increased by muscular exertion. 6. The nitrogen elimination is but slightly increased during muscular exertion. No considerable amount of nitrogenous muscular tissue is consumed. 7. The *immediate* fuel-material is mainly non-nitrogenous and carbohydrate in its character, probably in part at least derived from the muscle-glycogen, and perhaps from some other substances stored in some manner in the muscular tissue, possibly also to some extent from sugars conveyed to the tissues by the blood. 8. It is not certain to what extent this glycogen or other non-nitrogenous fuel-material is derived from nitrogenous or albuminoid material during rest or repose of the muscles, but such an origin, for a portion at least of the fuel-material, has some evidence in its favor. 9. The nature of the decomposition of this fuel-material is as yet an unsettled matter. The older theory of direct oxidation has been to a great extent replaced by the more modern theory of fermentative decomposition, i. e., splitting up by combination with water into simpler products with an accompanying release of energy, and this process followed by secondary oxidations exerted by the oxygen of the blood. Satisfactory experimental evidence for deciding with respect to these theories as yet fails us.

In conclusion, it is well, however, to recollect that at best the questions touched upon are but secondary to the more fundamental question upon which no investigation has as yet thrown even the most dim and feeble light, viz., "What is muscular force?" It seems impossible to conceive how a collection of cells with thin, elastic walls, and filled with a fluid or semi-fluid mass, can contract in such a way as to mani-

fest the power familiar to us as muscular force. We are here brought face to face with the same difficulties that meet us whenever we attempt to explore the mysterious physics and chemistry of living matter. The attempts which have been made to account for the peculiar selective power of the living cells of the rootlets of plants, to explain the selective action of the gland-cells of the kidneys which act partly according to laws of transudation and diffusion, and partly in opposition to those laws, have given us no satisfaction on those points. And it is the same with regard to the essential functions of other living tissues—all are carried on under the influence of the peculiar and uncomprehended properties of living matter.

We have gained, and are constantly gaining, valuable knowledge as to very many of the processes taking place in the living body, but as to the processes which take place in the truly living cells of gland, muscle, brain, or nerve, we are in almost complete darkness. At the doors of these most refined and mysterious of Nature's laboratories, we must lay down our rude tools and methods, and confess to ourselves that "thus far and no farther" may we hope to press our eager search for truth.

IDIOSYNCRASY.

By Professor GRANT ALLEN

EVERY man is, in the true Greek sense of the term, an idiosyncrasy. He is a *syncrasis*, because he derives all his attributes, physical or mental, from two parents, or four grandparents, or eight great-grandparents, and so forth. But at the same time he is an *idiosyncrasis*, because that particular mixture is eminently unlikely ever to have occurred before, or ever to occur again, even in his own brothers or sisters. That he is and can be at birth nothing more than such a *crasis*, that he can not conceivably contain anything more, on the mental side at least, than was contained in his antecedents, is the thesis which this paper sets out to maintain.

Take a thousand red beans and a thousand white beans; shake them all up in a bag together for five minutes, and then pour them out in a square space on a billiard-table just big enough to contain them in a layer one deep. Each time you do so, your product will be the same in general outline and appearance: it will be a quadrangular figure composed of beans, having throughout the same approximate thickness. But it will be a mixture of red beans and white in a certain order; and the chances against the same order occurring twice will be very great indeed. Make the beans ten thousand of each so as to cover the table ten deep, and the chance of getting the same order twice decreases proportionately. Make them a hundred thou-

sand each, and it becomes infinitesimal. You have practically each time not only a *syncrasis* but an *idio-syncrasis* as well.

Now, a human being is the product of innumerable elements, derived directly from two parents, and indirectly from an infinity of earlier ancestors; elements not of two orders only, but of infinite orders; combined together, apparently, not on the principle of both contributing equally to each part, but of a sort of struggle between the two for the mastery in each part. Here, elements derived from the father's side seem to carry the day; there, again, elements derived from the mother's side gain the victory; and yonder, once more, a compromise has been arrived at between the two, so that the offspring in that particular part is a mean of his paternal and maternal antecedents. Under such circumstances, absolute equality of result in any two cases is almost inconceivable. It would imply absolute equality of conditions between myriads of jarring and adverse elements, such as we never actually find in nature, and such as we can hardly believe possible under any actual concrete circumstances.

The case of twins comes nearer to such exact equality of conditions than any other with which we are acquainted. Here, the varying health and vigor of the two parents, or the difference between their respective functional activities at two given times, are reduced to a minimum; and we get in many instances a very close similarity indeed. Yet even among twins, the offspring of the same father and mother, produced at the same moment of time, there are always at least some differences, mental and physical; while the differences are occasionally very great. A competent observer, who knew the Siamese twins, informed me that differences of disposition were quite marked in their case, where training and after-circumstances could have had little or nothing to do with them, inasmuch as both must have been subjected to all but absolutely identical conditions of life throughout. One was described as taciturn and morose, the other as lively and good-humored. Whether anything of the same sort has been noticed in the pair of negro girls called the Two-headed Nightingale, I do not know, but, to judge from their photographs, there would seem to be some distinct physical diversities in height and feature. We can only account for these diversities in twins generally by supposing that in that intimate intermixture of elements derived from one or other parent, which we have learned from Darwin, Spencer, and Galton, takes place in every impregnation of an ovum, slightly different results have occurred in one case and in the other. To use Darwin's phraseology, some gemmules of the paternal side have here ousted some gemmules of the maternal side, or *vice versa;* to use Mr. Spencer's (which to my judgment seems preferable), the polarities of one physiological unit have here carried the day over those of another.

But why under such nearly identical conditions should there be such diversity of result? Let us answer the question by another:

Why, with a thousand red and a thousand white balls, shaken together with an equal energy by a machine (if you will), and poured out on our billiard-table, should there be a similar diversity? The fact is, you can not get absolute identity of conditions in any two cases. Imagine yourself mixing two fluids together with a spoon, as regularly as you choose; can you possibly make the currents in the two exactly alike twice running? And here in the case of humanity you have not to deal with simple red beans or with simple fluids, but with very complex gemmules or very complex physiological units.

If even in twins we can not expect perfect similarity, still less can we expect it in mere ordinary brothers and sisters. Here, innumerable minor physiological conditions of either parent may affect the result in infinite ways. Not, indeed, that there is any sufficient reason for supposing passing states of health and so forth directly to impress themselves upon the heredity of the offspring; but one can readily understand that, in a process which is essentially a mixture of elements, small varieties of external circumstances may vastly alter the nature of the result. Shake the bag of beans once, and you get one arrangement; shake it once more, and you get another and very different one. To this extent, and to this extent only, as it seems to me, chance in the true sense enters into the composition of an individuality. The possible elements which may go to make up the mental constitution of any person are (as I shall try to show) strictly limited to all those elements, actual or latent, which exist in the two persons of his parents; but the particular mixture of those elements which will come out in him—the number to be selected and the number to be rejected out of all the possible combinations—will depend upon that minute interaction of small physical causes, working unseen, which we properly designate by the convenient name of chance. In this sense, it is not a chance that William Jones, the son of two English parents, is born an Englishman in physique and mental peculiarities, rather than a Chinese or a negro; nor is it a chance that he is born essentially a compound of his ancestors on the Jones side and on the Brown side, but it is a chance that he is born a boy rather than a girl; and it is a chance that he is born himself rather than his brother John or his brother Thomas. If we knew all, we could point out exactly why this result and not any other result occurred just there and then; but, as we do not know all, we fairly say that the result is in so far a chance one. And, even if we knew all, we should still be justified in using the same language, for it marks a real difference in causation. William Jones is an Englishman and a Jones-Brown strictly in virtue of his being the son of Henry Jones and Mary Brown; but so are all his brothers and (*mutatis mutandis*) his sisters too. He is himself, and not one of his brothers or his sisters, in virtue of certain minute molecular arrangements, occurring between certain elements for the most part essentially identical with the elements which went to make up

the other members of his family. To be metaphorical once more, one may say that a Robinson differs from a Jones because he is a mixture of brown peas and white peas; whereas one Jones differs from another in being a particular mixture of red beans and black beans, differently arranged in each case.

Next after the similarity between brothers and sisters or other blood-relations, we may expect to find the similarity between the offspring of the same class in the same community, similarly situated: and this the more so in proportion to the average identity of their several lives. For example, one would naturally expect that our own agricultural laborers, all engaged in much the same sort of work and surrounded by much the same sort of objects, would produce by intermarriage very similar children. Still more would this be the case among very homogeneous savages, such as the Esquimaux or the South American Indians. And where the identity of pursuits is very great on both sides, and in all individuals, as among the Fuegians, the Veddahs, the Andamanese, we should expect to find a great likeness of physique and character between all the offspring.

Conversely, where marriages take place between persons of different races, or very differently situated, we may look for great differences between the offspring, especially when compared with those of marriages between relatively homogeneous persons. Under such circumstances, the children tend more or less, though very irregularly, to present a mean between the two parents. Thus, to take the most obvious instance, the average mulatto is half-way as a rule between the negro and the European, physically at least, though, for various reasons to be considered hereafter, it often happens that he is more than the equal in intelligence of the average white. But even in the same family of mulattoes great differences exist between the children. Some will be darker, others lighter; some will be curlier-headed, others straighter-haired; some will have prognathous faces and depressed noses, others will have more regular features and more prominent noses. So far as my observation goes, too, it does not always happen that the most European physical type has the most European mind: on the contrary, high intelligence often accompanies a very African physique, while English features may be concomitant with a truly negro incapacity for logical reasoning, generalization, or elementary mathematical ideas. It seems as though in each part there was a struggle for supremacy between the two types: and the one type may apparently carry the day in certain external peculiarities, while the other type carries the day in the more intimate arrangements of the nervous system. At the same time, I can not myself doubt that there must be a very intimate connection between every one of the sense-organs and the brain; and I can hardly believe that prognathism and other like physical peculiarities do not imply various correlated nervous facts of great psychological importance. Though, in the result-

ing compromise between the two diverse heredities, the one seems largely to prevail over the other in certain parts, yet it is difficult to suppose that there is not a minute interrelation between all the parts: and perhaps the significant fact that every mulatto, though darker or lighter, is at least brown, not purely black or purely white, gives us the best key to the true nature of the situation.

So far, I have been tacitly but intentionally taking for granted the very principle which I set out to prove, in order fully to put the reader in possession of the required point of view. The question now arises, Where in this series of events is there room for any fresh element to come in? Can any man ever be anything other than what some of his ancestors have been before him? And, if not, how is progress or mental improvement possible? That men have as a matter of fact risen from a lower to a higher intellectual position is patent. That some races have outstripped other races is equally clear. And that some individual men have surpassed their fellows of the same race and time is also obvious. How are we to account for these facts without admitting that new elements do at sundry times creep in by chance, in the false and unphilosophical sense of the word? How can we get advance unless we admit that exceptional children may be born from time to time with brains of exceptional functional value, wholly uncaused by antecedents in any way?

The answer to this question is really one of the most important in the whole history of mankind. For on the solution of the apparent paradox thus propounded depend two or three most fundamental questions. It is by this means alone that we can account, first, for the existence of great races like the Greeks or the Jews. It is by this means alone that we can account, secondly, for genius in individuals. And it is by this means alone that we can account, thirdly, for the possibility of general progress in the race. It is surprising, therefore, that the question has so little engaged the attention of evolutionary psychologists at the present day.

There are only two conceivable ways in which any increment of brain-power can ever have arisen in any individual. The one is the Darwinian way, by "spontaneous variation"—that is to say, by variations due to minute physical circumstances affecting the individual in the germ. The other is the Spencerian way, by functional increment —that is to say, by the effect of increased use and constant exposure to varying circumstances during conscious life. I venture to think that the first way, if we look it clearly in the face, will be seen to be practically unthinkable: and that we have therefore no alternative but to accept the second. Deeply as I feel the general importance of Darwin's theory of "spontaneous variation" (using the words in the sense in which he always used them), it seems to me that that theory can not properly be applied to the genesis of a nervous system, or of any part of a nervous system, and that in this case we must rather come

back to the genesis worked out by Mr. Herbert Spencer in the part of his "Principles of Psychology" entitled "Physical Synthesis."

For let us for a moment try to imagine a nervous system being produced, or increased in value, by natural selection of spontaneous variations alone, without the aid of functional variations at all. It is easy to see that an animal or a plant may vary indefinitely here or there in color, or in hardness of skin, or in woodiness of tissues, and so forth; and it is easy to see that among these truly "accidental" variations* some may be better adapted to their particular environment than others. But can we imagine, say, an eye to be produced by a series of such individual accidents? I do not say a human eye, but a simple pigment cell, with a nerve given off from it to a ganglion as in the case of the *Amphioxus?* And if we can imagine this (which I can not), can we imagine a child being born into the world, gifted, I do not say with innumerable faculties never possessed by his ancestors, but with a single nerve-cell or nerve-fiber more than they possessed? Just let us look at what a palpable absurdity this notion implies.

Here is William Jones's head, containing an average human brain, developed on the same pattern as his father's brain (or as his father's in part and his mother's in part): and here in a particular spot in a particular convolution of it, by a combination of mere physical circumstances, has arisen a totally new and hitherto non-existent nerve-cell. Clearly, this is an acquisition to the race, by way of spontaneous variation. But what is the functional use of this new nerve-cell? What physical circumstance decides whether it is to answer to a new movement in the left little finger, or to a single creative element in the composition of a future fugue? Let us grant a little more: let us suppose the surrounding cells are all concerned in the appreciation of color, or in the manipulation of numbers. Will the new cell in the first case answer to a new and hitherto undiscovered color or to a further æsthetic pleasure in an existent color, or to a higher synthesis into which colors enter as elements; or what in the second case will be its mathematical value? Again, what good will it be without a whole network of connecting fibers which will link it to percipient structures in the eye on the one hand, and to all the various higher layers in the stratified hierarchy of color-thought elements or number-dealing elements on the other hand? Granted that one man in a hundred was born with one such new cell in his brain, and (setting aside the question how the cell comes to have any function at all) what are the

* It is a great pity that to this day one is always obliged to employ this useful term with a caution in the way of quotation-marks, in order to avoid a supposed philosophical scholar's-mate from sixth-form critics. "Accidental" in biology means, of course, "produced by causes lying outside the previous vital history of the race"; in a word, "individual." Among such accidental variations survival of the fittest preserves a few. But it is annoying that one can never use so transparent a phrase without being informed magisterially by a lofty reviewer that the word accidental is unphilosophical, and that nothing ever happens in nature without a cause.

chances that that cell would be so connected with other cells elsewhere as to make any part of an organized brain? Can we imagine a new cell so imported, connected in rational manners with hundreds of other cells, in any other way than by a miracle? Which is only a different form of saying, can we imagine it at all?

But here, again, is something more than William Jones's head; here is, let us say, a great poet's, or a great philosopher's, or a great mathematician's head; and here are the upholders of spontaneous variation asking us to believe, not that one cell within it thus spontaneously varied in the right direction, but that a vast number of cells and fibers all varied simultaneously and symmetrically, so as to produce a harmonious and working whole, capable of giving us Othello, or the Evolution Theory, or the Differential Calculus. Why, the thing is clearly impossible—impossible, that is to say, as a result of "accidental" physical causes. We might just conceivably imagine one or two fibers made to connect one or two hitherto unconnected nerve-cells, though even here the probability that the nerve-cells so connected were of heterogeneous orders would be far greater than the probability that they were of homogeneous orders; we could much more readily imagine such connections resulting in a potentiality for believing that a lobster's tail was a blue hope of raspberry watches than in a potentiality for believing that water was composed of hydrogen and oxygen, or that propositions in A were not convertible. But we certainly can not imagine a whole network of such fibers to spring up by spontaneous variation in a human brain, and yet to produce an organized result. If spontaneous variation ever works in this way, its product must surely be either an idiot or a raving madman. To believe the opposite is too much like believing in Mr. Crosse's electrical *Acari*, which were developed *de novo*, out of inorganic material, in a dirty galvanic battery, and yet possessed all the limbs and organs of degenerate spiders. It is asking us once more to accept a still greater miracle than the first.

But such miracles, it is urged, do take place elsewhere in nature. For example, an almond-tree, let us say, once produced a peach-bearing branch by bud-variation. Hence it has been inferred that the peach is a spontaneous variation on the central almond theme. Yet peaches are in color, fleshiness, sweetness, and perfume, true fruits, adapted to the fruity method of dispersion, by means of attracting birds; whereas the almond is a nut, with the usual nutty peculiarities of green and brown color, dryness, absence of sweet juice, and so forth. In this case, then, it would seem that bud-variation immediately produced a variety adapted to a different environment in ever so many distinct ways. Well, I have introduced this case, just because it illustrates the very impossibility of such a supposition. For it seems pretty clear that if peaches have grown at one act from almonds, then this must really be a case of reversion; the almond must

itself be a dried-up form of a still earlier peach; and this will be equally true even if all the existing peaches can be shown to be descended from nut-like almonds. For the almond is a plum by family; and all the other plums have juicy fruits; while one of them, the apricot, closely approaches the almond-peach group in most of its characters. Seeing, then, that the almond must almost certainly be descended from juicy fruit-bearing ancestors, nothing is more natural than that under altered circumstances it should revert, *per saltum*, to a juicy peach. But to suppose that the peach type was originally developed *per saltum* from an almond is to suppose that it varied at once in several separate ways, all equally and correlatively adapted to a particular mode of dispersion. It is to suppose that accident could do in a minute what we have every reason to believe can only be done by infinitesimal variations and infinite selection.

But if the naturalist can not imagine the production of a peach *de novo* out of an almond at a single jump, how can he imagine the production of a new thinking element in a human brain? How can he suppose that the accidental introduction of one more little bit of matter into that vast organized labyrinth—a mighty maze, but not without a very definite and regular plan—can have any kind of intelligible relation to the complicated system of cross-connections and superimposed directive departments which make it up? And if it be objected that the view taken above of the constitution of the brain is wooden and mechanical, I would answer that it is certainly absurdly diagrammatic and inadequate, but that it is so far right in that it insists upon making believers in spontaneous variation try to realize their own unthinkable attitude. As to materialism, surely it is more profoundly materialistic to suppose that mere physical causes, operating on the germ, can determine minute physical and material changes in the brain, which will in turn make the individuality what it is to be, than to suppose that all brains are what they are in virtue of antecedent function. The one creed makes the man depend mainly upon the accidents of molecular physics in a colliding germ-cell and sperm-cell; the other creed makes him depend mainly upon the doings and gains of his ancestors, as modified and altered by himself.

And now let us look at this second creed, in order to see how far it surpasses its rival in comprehensibility, concinnity, and power of explaining all the phenomena. If it be true that all nerve-increment and especially all brain-increment is functionally produced, we can easily understand why each new cell or fiber should stand in its true and due relation to all the rest. It will have been evolved in the course of doing its own work, and it will be necessarily adapted to it because the act of working has brought it into being. There will be no doubt whether the new cell governs the peculiar action of the left little finger in performing that amusing conjuring trick, or is, on the contrary, connected with the perception of orange-red, because the cell

was actually differentiated (say out of pre-existing neuroglia, though that is a hypothetical matter of detail) in the very act of performing the trick in question. There will be no doubt whether the new fibers are related to the arithmetical faculty or to the Sanskrit verbs, because they were actually rendered possible as nervous tracks in the act of learning decimal fractions. It is true, we may admit to the utmost the intense complexity of the existing brain, and the vast number of its elements involved in even the simplest muscular adjustment or the simplest visual perception. Nobody feels the necessity for admitting such complexity more fully than myself. One may allow with M. Ribot that every act of thought must be conceived rather as a vast dynamical tremor, affecting a wide plexus of very diverse nerve-elements, than as a single function in a single cell or fiber. One may acknowledge that what one ought really to picture to one's self (at the present stage of human evolution) is not so much the genesis of a new cell for governing the little finger, or of a new fiber for understanding a fact in decimal fractions, as the habituating an immense series of cells and fibers, perhaps in various parts of the brain, to thrill together in unison on the occurrence of a single cue. But let us thus purify and dematerialize our conception as far as we like, we must nevertheless come back at last to the fact that every gain implies a modification in structure, and that this modification in structure, if it is to have any functional meaning and value whatsoever, must be functionally brought about.

That such functional modifications are forever taking place in all of us is a matter of common observation, as evidenced by psychological facts. We are always seeing something which adds to our total stock of memories ; we are always learning and doing something new. The vast majority of these experiences are similar in kind to those already passed through by our ancestors ; they add nothing to the inheritance of the race. To use a familiar phrase in a slightly new and narrower sense, they do not help to build up "forms of thought" ; though they leave physical traces on the individual, they do not so far affect the underlying organization of the brain as to make the development of after-brains somewhat different from previous ones. But there are certain functional activities which do tend so to alter the development of after-brains ; certain novel or sustained activities which apparently result in the production of new correlated brain-elements or brain-connections, hereditarily transmissible as increased potentialities of similar activity in the offspring. If this is not so, then there is no meaning at all in the facts collected by Mr. Galton, or, indeed, for the matter of that, in the common facts of human experience as to hereditary transmission of faculties for acquired pursuits of any sort. If the children of acrobats make the best tumblers, if the descendants of musical families make the best singers and composers, if a great thinker or a great painter is usually produced by the convergence of

two lines of thinkers or artists, then the general truth of this principle is abundantly clear.

Supposing such small functionally-produced modifications to be always taking place, it will be obvious that they must take place most in the most differentiated societies, and least in the least differentiated. A race of hunting savages will perform a certain number of routine acts, which will be for the most part the same for all members of the tribe, and will remain pretty much the same from generation to generation. In the particular direction of hunting and fishing, the cleverness at last attained will be very remarkable; but in most other directions there will be little excellence and still less variety. On the other hand, in a tribe which is also made a trading and navigating one by the accident of a maritime position, a new set of activities will be specially cultivated, and will give rise to new functional modifications in a different direction. Suppose some of the tribe, in this latter case, to be mainly inland cultivators and hunters, while others of the tribe are mainly seaboard traders or pirates, then each of these sections will tend to develop certain special hereditary brain-modifications of its own. But if a man of the inland section marries a woman of the maritime section, or *vice versa*, then the offspring will tend to reproduce more or less the structural peculiarities of both parents. And here comes in an important corollary. For though, under such circumstances, the children may none of them fully reproduce all the brain-gains of their father's line, nor all the brain-gains of their mother's line, they will yet on the average reproduce a fair share of the former and a fair share of the latter. Accordingly, they will usually turn out, on the whole, persons of higher general brain-power than either ancestral series; they will partially unite the strong points of both.

It seems to me that this principle is one of very great importance. From it we can deduce the conclusion that in any complex society many children represent directly a convergence of two unlike lines of descent, and indirectly a convergence of innumerable unlike lines, with corresponding gain to the species. Two parents, possessing distinct points of advantage of their own, produce children, some of whom resemble rather the one, and some the other; but many of whom will at least tend to resemble both in their stronger points. Of course, one must allow much for the *idiosyncrasis* as well as for the *crasis*. This child may fall below both its parents in most things; that child may reproduce the weakest elements of both; yonder other child may attain the average or may surpass them in everything. But, on the whole, the principle of convergence seems to imply that in a fairly complex society there will always be an average of mental improvement from generation to generation, due to the constant intercrossing of brains specially improved in particular directions. This improvement will, it need hardly be said, be increased and favored by natural

selection; but it will itself form the basis of favorable variations without which natural selection can do nothing. It seems to me easy to understand how survival of the fittest may result in progress, starting from such functionally-produced gains: but impossible to understand how it could result in progress if it had to start from mere accidental structural increments due to spontaneous variation alone.

Thus it becomes clear why certain countries have by mere geographical position necessarily produced certain high types of human intelligence, while in certain other countries the race has never progressed beyond a very low level. There are places like Central Africa, where the physical conditions do not tend to produce any great diversity of occupation; and here the general average of intelligence does not tend to rise high. On the other hand, there are places, like Greece, Italy, the West European peninsulas and islands, where the physical conditions tend to differentiate the population into many groups, agricultural, mercantile, sea-faring, military, naval, and professional; and here the general average of intelligence tends to rise very high indeed. Of course, one must allow much influence to the time-element; for every such increase in differentiation involves yet further increases in the sequel, and brings the social organism, or parts of it, into contact with new environments. The Ægæan is not now of the same importance in this respect as during the days when coasting voyages from island to island were the utmost possible stretch of navigation: the science acquired there has widened the sphere of navigation itself, first to the entire Mediterranean, then to the open Atlantic, finally to all the oceans of the whole earth. But in principle it has always seemed to me (as against the really accidental view advocated by Mr. Bagehot) that the "philosophy of history," the general stream of human development, could be traced throughout to perfectly definite physical causes of this sort. Mr. Bagehot, basing himself on the pure Darwinian theory of spontaneous variations, believed that the differences between races of men were due to mere minute physical sports in their nervous constitution: it appears to me rather that they are due to the action of a definite environment, thus effecting a differentiation of circumstances, and in many cases calling into constant functional activity the highest existing faculties of the various social units in the most diverse ways. We may not thus (though *vide post*) be able to account for the particular character and genius of a Pericles, an Aristotle, a Hannibal, a Cæsar, a Newton, or a Goethe; but we can thus at least account for the general average of intelligence which made Greece, or Carthage, or Rome, or England, or Germany, capable of producing such an individual, as a slight variation on the common type, due to the convergence of separately rich and varied lines of descent. The real illuminating point is this—that such men do arise from time to time among the most intelligent na-

tions, and that they do not arise among the Australian black-fellows, the Digger Indians, or the Andaman-Islanders.

And now, how far can we account on these principles for the existence of the individual genius? Well, here we must begin by clearing the ground of a great initial fallacy. Genius, as a rule, has made quite too much of itself. Having had the field all to itself, it has never been tired of drawing a hard and fast line between itself and mere talent. Nevertheless, from the psychological point of view, nothing is plainer than the fact that genius differs from mere talent only by the very slightest excess of natural gifts in a special direction. True, that small amount of superiority makes all the difference in our judgment of the finished work: we say, this is a great poem, while that is a pretty trifle; this is a grand scientific generalization, while that is a painstaking piece of laboratory analysis; this is a magnificent work of art, while that is a very creditable little bit of landscape-painting. But, in the brain and hands of the performer, what infinitely minute structural modifications must underlie these seemingly vast differences of effect! And even in ourselves, the critics, how minute are the shades of feeling which make us give the palm to the one work and withhold it from the other! How many people are really competent to judge in any way of the differences between this poem and that, between this oratorio and that, between this picture and that? And what is this but to say that the differences are in themselves extremely small and almost elusive?

Now, in a country like Italy, say, where for many ages many men have continually painted pictures of the nymphs and the satyrs, or of the Madonna and of St. Sebastian; where little chapels have studded the land, from age to age, with votive tablets to Venus Genitrix or to Our Lady of the Sea; where countless generations of workmen have decorated the walls of Pompeii or covered the vulgarest ceilings of Florence and Genoa with hasty frescoes—in such a country there is developed among all the people a general high average of artistic execution, utterly impossible in a country like Scotland, where there has hardly ever been any indigenous spontaneous art at all to speak of. And when an Italian man of an artistic family, having inherited from his ancestors certain relatively high artistic endowments, marries an Italian woman of another artistic family, similarly but perhaps somewhat differently endowed, there is at least a possibility, not to say a probability, that their children, or some or one of them, will develop great artistic power. True, we can not follow the minute working of the *crasis:* we can not say why Paolo is an artist of the highest type, while Luigi is merely a fair colorist, and Gianbattista is a respectable copyist of the old masters. But at least we can say that all three are painters after a fashion, in virtue of their common artistic descent; and that Paolo is a great painter because he unites in himself, more than either of the others, the respective merits of the two ancestral

lines. After all, we common mortals, if we practiced all our lifetime, could not turn out as good a sketch as Gianbattista's first water-color.

In the same way, in a Greece where every god had his temple, every temple its statue, every house its shrine, and every shrine its little deities—in a Greece where marble was what brick is in London, and where artistic stone-cutters were as common as carpenters here—we can understand why a Phidias was a possible product, and why a Phidias-admiring public was a foregone conclusion. So, too, we can understand why among ourselves so many artists should come from the only real native schools of decorative handicraft—the workshops of Birmingham, Manchester, and London. We can see why musical talent should arise most in Germany and Italy, or among the Jews, or in our own case among the Welsh and in the cathedral towns. We can see why a Watt is not born in the Tyrol; why a Stephenson does not come from Dolgelly; why America produces more Edisons, and Bells, and Morses, and Fultons than she produces Schillers, or Mozarts, or Michael Angelos. The convergences which go to produce a great mechanician are more frequent in countries where mechanics are much practiced than they are in the Western Hebrides or in the British West Indies. The Quakers do not turn out many great generals, and the kings of Dahomey are not likely to beget distinguished philanthropists.

Of course, there are some hard cases to understand—hard for the most part, I believe, because we do not know enough about the various convergent lines which have gone to produce the particular phenomenon. Here and there, a great man seems to spring suddenly and unexpectedly from the dead level of absolute mediocrity. But then, we do not know how much mediocrity in different lines may have gone to make up his complex individuality; and we do not know how much of what seems mediocrity may really have been fairly high talent. So many men are never discovered. Let me take a few slight examples from our own time, which may help to illustrate the slightness of the chances that make all the difference in our superficial judgments; and, if I take them from very recent cases, I think the readers of "Mind" will not misunderstand my object; for it is almost impossible to recover the facts from remoter periods.

Carlyle, in spite of his spleen, was no bad judge of intelligence; and Carlyle thought Erasmus Darwin, the younger, an abler man than his brother Charles, the author of "The Origin of Species." Probably nobody else would agree with Carlyle; people seldom do; but at any rate it is clear that Erasmus Darwin must have been a man very high above the average in intellect, doubtless inheriting the same general tendencies which are inherent in the whole of that distinguished family. Yet, if it had not been for his brother, probably the world at large would never have heard of him. Again, supposing he had had no brother, but had married and had children, all of whom achieved celebrity, we might have inquired in vain whence these children came

by their ability. Once more, take Charles Darwin himself. He was nearly if not quite fifty before he published "The Origin of Species." It was a mere chance that with his feeble health he lived on to complete that great work. Suppose he had died at forty, how would he have been remembered? Chiefly as the author of a clever book of scientific travels, and of a monograph on the fossil acorn-barnacles. In a world of such mere accidents as these, who shall say that an apparently negative instance proves anything?

Take another and somewhat different case—the Tennyson family. Here we have three brothers, all with more or less poetical temperament, and all marked by much the same minute peculiarities in cast of thought and turn of expression. Only two, however, I believe, have published or at least have acknowledged their verses; and of these two alone—Alfred Tennyson and Charles Tennyson Turner—has one a right to speak publicly. When the "Poems by Two Brothers" appeared, who could have said which of the two was destined to turn out a great poet? And in the after-event, who can say what little difference of circumstances may have made the one into a clergyman and the other into a professional versifier? If Charles Turner had cultivated his muse as assiduously as the laureate, would he have produced equal results? What little twist set the one, with Tennysonian love of form carried to the length of a passion, upon the writing of exquisite sonnets alone, while it set the other upon "In Memoriam," and "Maud," and "The Princess," and the "Morte d'Arthur"? What little extra encouragement on the part of a reviewer may have impelled the more successful poet to fresh efforts; what professional distractions or religious scruples may have held back the less illustrious parson? And yet, who can read Charles Tennyson Turner's sonnets without feeling that though the *idiosyncrasis* is not exactly the same, the *crasis* itself is at bottom identical? Compare the sonnets with the work of any one among the imitators—the men who "all can raise the flower now, for all have got the seed," and what a difference! The imitator is all servile copyism in form, with no real underlying identity of matter; the brother is only half a Tennyson in mere externals, but is still own brother in the most intimate turns of thought and feeling.

After such cases as these, do we need any explanation of the sudden apparition of a Carlyle, a Burns, a Shakespeare, a Dickens, from out the ranks of the people themselves? To me it seems not. Are there not pithiness and sternness and ability enough in the Lowland peasantry to account for the occasional production, out of thousands of casts at the dice, of such a convergence as that which gave us the old man at Ecclefechan who "had sic names for things and bodies," and his two able sons, of whom the more strangely compounded was Thomas Carlyle? Is there not in another type of Scotch peasant enough of pathos and literary power and *bonhomie* to account for an

occasional convergence which will give us either the old popular-song-writers, or Burns himself, or on a slightly lower level such a woman as Janet Hamilton? Again, the case of Dickens looks at first sight somewhat more difficult; but then one may remember that, as far as general mental power went, Dickens was nowhere. He was a pure artist in a special and very restricted line; he possessed a peculiar faculty for describing queer and original people in a queer and original way. Doubtless this faculty was in him so fully developed that it rose to the rank of genius in its own line; but the line was by no means an exalted one. In such a case, who can say what quaint little combinations of ordinary elements went to make up the power that amused and delighted us so much? Are there not thousands of people in our midst who possess just the same faculty in a less degree—people who, without depth or brilliancy in other respects, can raise a laugh, by their clever caricatures of the habits and conversation of their friends? Throw in the merest side-twist of comical exaggeration and a grain of plot-forming capacity into such a *raconteur*, and you get the framework for the genius of Dickens. Of genius of that sort, indeed, more than of any other, one may fairly say that it differs only by a hair's breadth from humorous mediocrity. It is otherwise, I believe, with really deep philosophical or scientific power. Grasp, insight, luminousness, breadth; the capacity for dealing with the abstract ideas of mathematics, of logic, of metaphysics; the power of seeing or formulating great generalizations—these things, if I read the lives of thinkers aright, come only from a convergence of able and powerful stocks. It takes three generations, they say, to make a gentleman; surely it takes many generations of trained intelligence on both sides to make a philosopher.

At the same time, it must be remembered that a convergence even of two mediocre strains may produce comparatively high results, provided the endowments of the two strains be complementary or supplementary to one another. To this cause may perhaps be attributed the general high level of intelligence displayed by half-breeds—even half-breeds with a lower race. I have already alluded to the intellectual superiority of mulattoes, a large proportion of whom appear to me (and to some other observers) considerably above the average of either Europeans or negroes. And this is not surprising when we recollect that the negro brain, though relatively inferior, must almost necessarily be highly cultivated in some particular directions, where the European brain is comparatively deficient. If, then, a mulatto child inherits in fair degrees the quick perceptive faculties and intuitions of his mother, and the higher reasoning faculties and forethought of his father, he is likely on the average to be better equipped in inherited potentialities than either.* Similarly, one may take it for granted

* Darwin has somewhere noted that half-breeds with lower races appear to be on the whole often morally inferior to either parent race; and he has suggested that this inferiority

that each great European nationality has some strong points not equally shared by the others; and it is a trite observation that intermarriages between members of such nationalities tend to produce an unusually high level of general intelligence. In Ireland, the mixed French families, sprung from intermarriages with refugees, have long been noticed in this respect; at Norwich and throughout the eastern counties, the mixed descendants of the Huguenots (such as the Martineaus and others) have been equally distinguished. Perhaps one might even point out an exceptional amount of intellectual power in the more mixed Celtic and Teutonic regions of Britain—the borderlands of the two races—notably at Aberdeen and in Devonshire. But the most remarkable and least dubious instance is that of the mixed offspring of Jews and Christians. Here we start with a pure race of unusual intellectual vigor and power, the Jews long thrown by circumstances into an environment which has brought out many of their faculties in a very high degree. They are the oldest civilized race now remaining on the earth; they are artistic, musical, literary, exceptionally philosophic, and hereditarily cultivated. Even by marriage among themselves they naturally produce a very large proportion of remarkable men. But when they marry out with Christian women—in other words, with women of the European race—the special Aryan traits seem to blend with the Semitic in a very notable and powerful mixture. I have not space to give illustrations, but the list that can be compiled of distinguished persons of half-Jewish blood is something simply extraordinary, especially when one remembers the comparatively small sum-total of such intermarriages. Indeed, the difficulty would probably be to find a single person of mixed Jewish race who was not at least above the average in intellect and in plasticity of thought.

Finally, it seems to me that unless we accept the view here contended for, that all increments of brain-power are functionally produced, the whole history of human development ought to present the appearance of a continuous chaos. Granted this principle, we can understand why a Phidias appeared in Greece, a Raffaelle in Italy, a Watt in Britain; without it, we can not understand why they should not all have appeared in Iceland or in New Guinea just as well. If mere physical circumstances affecting germs and sperm-cells can pro-

may be due to reversion to an earlier and still more savage type of humanity. Without expressing any opinion on the question of fact (a delicate one to decide), I fancy another explanation fits more simply: namely, that as morals are a comparatively recent and unstable acquisition even in the best and highest, they do not crop up in the half-breed; and the union of relatively high European intelligence with relatively low savage ethics may easily produce what seems at least to be a very brutal and diabolical nature. Surely there can be nothing worse in any savage than such abnormal products of our own civilization as Peace the murderer, or as the man Thomasson who attempted to blow up an Atlantic steamer by a piece of dynamite clock-work for the sake of obtaining the insurance.

duce miraculous and really uncaused new developments of structure and function—can make a genius spring from nobodies, and a philosopher grow at one leap out of two common strains, of the earth, earthy—then we can see no reason why there should not be great families, great epochs, great outbursts in any one place as well as another. But if all increments are functionally acquired, then we can understand why this environment produces races of sculptors, that environment races of poets, yonder environment races of traders, or thinkers, or soldiers, or mechanicians. The first hypothesis is one that throws no light at all upon any of the facts; the second hypothesis is one that explains them all with transparent lucidity.—*Mind.*

ÉTIENNE GEOFFROY SAINT-HILAIRE.

THE name of ÉTIENNE GEOFFROY SAINT-HILAIRE is most intimately associated with the establishment of the doctrine of the unity of the organic plan of the animal kingdom. This great naturalist was born at Étampes, France, April 15, 1772, and died in Paris, June 9, 1844. He came of an honorable family, of only a moderate fortune, another branch of which had given three members to the Academy of Sciences. His father, Jean Gérard Geoffroy, an attorney and magistrate, designed him for the ecclesiastical profession. So, after having taken his primary studies at home, he obtained a bursarship in the college of Navarre, and, about 1788, a canonry and a benefice at Étampes. Everything thus promised well for his ecclesiastical advancement; but he felt drawn toward the natural sciences by an irresistible taste, which the experimental lessons in physics of Brisson had contributed to develop. On leaving the college, he asked permission of his father to remain in Paris, to attend the courses of the *Collège de France* and the *Jardin des Plantes.* The father consented, and toward the end of 1790 the young man became a bachelor-in-law. He went no further in this profession, but sought in medicine a calling more congenial to his tastes, without remaining faithful to that. He entered the college of Cardinal-Lemoine as a *pensionnaire*, where he attracted the notice of Lhomond and Haüy, who were teaching there. Daubenton, whose lectures in the *Jardin des Plantes* he was attending, remarked him among his pupils, invited him to his house, charged him with commissions relative to the lectures, and intrusted to him the determination of some of the objects in the collections of the *Jardin.*

The French Revolution was now (1792) raging furiously, and all the professors in the college were arrested on the 13th of August for the crime of being priests. Haüy was released on the next day, through the most active exertions of Geoffroy, and Lhomond was delivered by one of his former pupils. The other priests were detained

in the prison of Saint-Firmin, near Geoffroy's residence; and he, on the 2d of September, getting access to the prison under a disguise, signified to them that he intended to help them escape. "No," said the Abbé de Keranran, "we will not leave our brethren, for that would only make their destruction more certain." Geoffroy, however, got a ladder, and took it after nightfall to the corner of the prison-wall which he had designated, and waited for eight hours before the first priest appeared. One of the prisoners hurt his foot in jumping, and our hero carried him in his arms to a neighboring yard. Twelve of the priests had been rescued, when one of the guards fired a gun, the shot from which went through Geoffroy's clothes, and aroused him to the fact, which he had not noticed, that the sun had risen. He then returned home; but, though he had arranged to meet the priests afterward, he was not destined to see them again; and, when he went to the appointed rendezvous, he found himself alone. Exhausted by his efforts, Geoffroy hurried home to Étampes, where he fell dangerously ill, but was brought back to health under the salubrious influence of the fresh country air. Haüy's letters to him at this time attest the affection which existed between the master and his pupil. In one of them the great mineralogist wrote (October 6, 1792): "Your letter reached me just as I was going out to dinner; it was like a delicate dessert, of which I immediately gave a part to M. Lhomond; we were never so happy at the table except when you were really with us"—and then he advises Geoffroy to suspend for a while, for the sake of the restoration of his health, the hard study of crystallography, and attach himself to plants, "which present themselves under a more graceful mien and speak a more intelligible language. A course in botany is all pure hygiene." Geoffroy resumed his studies in Paris in November, and in March following, at the request of Daubenton and on the nomination of Bernardin de Saint-Pierre, he was appointed sub-keeper and assistant demonstrator in the Natural History cabinet of the *Jardin des Plantes*. On the reorganization of the *Jardin des Plantes* as the Museum of Natural History, in June, 1793, he was named to the chair of Zoölogy of Vertebrated Animals. He hesitated to accept the position because his studies had been in mineralogy, but Daubenton persuaded him to do so. Immediately after his installation, he began the foundation of the menagerie of the *Jardin des Plantes*, beginning with three itinerant collections of animals that had been confiscated by the police and taken to the museum. Of what he accomplished in this department he has written: "When I began to direct my studies to the natural history of animals, that science had not been encouraged at Paris. It had never been made a branch of instruction, and I did not expect that I should shortly be made the first one to treat it in a public course. Established in the year II (1793–94) as Professor of the Natural History of Mammalia and Birds, I became also an administrator in the museums of the collections of these classes. There were then

only a few quadrupeds in the national collection. My duty was to try to increase the number. I entered into correspondence with the principal naturalists, I was powerfully seconded by their zeal, and the collection of viviparous quadrupeds or mammals is now the richest of that class in existence. I have likewise greatly enriched the collection of birds. Finally, I have made the collections useful to young naturalists by making rigorous determinations of the animals intrusted to my administration."

The course was opened in May, 1794, and in the following December Geoffroy read to the Society of Natural History an essay on the aye-aye, in the introduction to which, criticising the views of Bonnet on the scale of beings, he attacked a theory that was but slightly different from the one which he himself afterward adopted.

In 1795 the Abbé Tessier had found in Normandy a youth who was strongly interested in natural history, and gave an account of him to Geoffroy, to which the young man added a communication describing some of his researches. Geoffroy wrote back to the youth: "Come to Paris without delay; come, assume the place of another Linnæus, and become another founder of natural history." The youth came, and thus was opened the career of the illustrious Georges Cuvier. He and Geoffroy became fast friends, and together composed five memoirs, of which one, on the classification of mammalia, contained the theory of the subordination of characters, fundamental to Cuvier's system. In a memoir on the Makis, or Madagascar monkeys, published a year afterward by Geoffroy alone, appears the principle of unity of composition, to which the author afterward related all comparative anatomy. The minds of the two friends had already begun to diverge toward opposite systems.

In 1798 Cuvier and Geoffroy Saint-Hilaire were invited to accompany Bonaparte on his expedition to Egypt. Cuvier declined, Geoffroy went. There he was one of the members of the scientific commission that explored the Delta, and of the Commission of Seven for the organization of the Institute of Egypt, which distinguished itself by its archæological labors. He made in succession journeys through the Delta, to Upper Egypt, and to the Red Sea. After his return from the Cataracts, at the end of 1799, he established himself at Suez, and began a collection of the fishes of the Red Sea.

On the evacuation of Egypt by the French, the scientific party were confined to Alexandria, where, amid all the perils of the siege, Geoffroy continued his scientific investigations and his examinations of the electrical fishes of the Nile. When the city was given up, no reservation was made of the collections, but Geoffroy managed to save them. General Hutchinson demanded a strict execution of the terms of surrender, and sent Hamilton to enforce them upon Geoffroy's treasures. "No," said Geoffroy, "we shall not obey the orders; your army can not get in here for two days: we will take that time to burn

our cabinets, and then you can do with our persons as you please. Yes," he added, to the astonished officer, "we shall do it. You are seeking for fame. Depend upon it, history will give it to you, for you also will have burned an Alexandrian library." These bold words were reported to Hutchinson, and he rescinded the order for seizing the collections.

Returning to France in 1802 with the magnificent zoölogical and zoötomical collections thus literally saved from the fire, Geoffroy proceeded to classify them and prepare the description of them for the grand work on the expedition to Egypt, and began the series of monographs that served as the point of departure and as supports for his system of natural philosophy. He was already outlining his theory of unity of composition, in memoirs which, aside from novelty and elevation of ideas, contained, according to Cuvier, "facts very curious and generally new, and added much to the knowledge of naturalists and anatomists on the interior organization of fishes." These memoirs secured the author's admission to the Academy of Sciences in September, 1807.

In 1808 Geoffroy Saint-Hilaire was charged with a scientific mission to Portugal, then occupied by a French army under Junot. He was exposed to many perils in passing through Spain, where the people were restive against the French invasion, and was held a prisoner for several months at Merida. He used his influence with Junot, an old comrade of his in Egypt, to make the condition of the Portuguese more easy under military rule, and took away from the country many cases of mineralogical specimens, plants, and animals, including Brazilian ones, but in turn enriched the museum at Lisbon with a valuable cabinet of minerals from Paris, and set in order the collections there, which had hitherto been only the object of an unintelligent curiosity; and, by his tact and reputation for a general benevolent disposition, he managed to keep what he had acquired from Portugal when the French were obliged to give up everything else they had taken from foreign nations.

In 1809 Geoffroy was appointed Professor of Zoölogy in the Faculty of Sciences at Paris, and toward the end of the year he began a course of instruction which was destined to have a great influence upon his hearers and on himself. "From this moment," says M. Dumas, "his thought, sustained by the respectful attention of distinguished pupils, and particularly by their philosophical studies, sprang more freely into the fields of abstraction, and succeeded in fixing those laws of organization to which his name will continue to be always attached, and which he had long perceived. Till then anatomical philosophy, as he conceived it, had no existence; it was with us and for us that he founded that doctrine, endeavoring every year to overcome new difficulties, fortifying his convictions with new proofs, and confirming himself in his views by their success, even while they were yet

new." Sickness in 1812, and the disasters of the country in 1813–'14, interrupted his scientific work. In 1815 he was chosen a representative by the electors of Étampes, and performed the functions of his office with credit, till the Restoration put an end to them. Restored to science, he expounded his system in a work entitled "Philosophie Anatomique" ("Anatomical Philosophy"), the first volume of which, treating of the respiratory organs and skeletons of vertebrates, appeared in 1818. The second volume, devoted to researches on human monstrosities, was published in 1822. The dominant feature of these two volumes was the principle of unity of composition. This principle was not entirely new to science. It had been glanced at by Aristotle, Pierre Belon, Newton, Buffon, and Vicq-d'Azyr; but it remained for Geoffroy Saint-Hilaire to create a theory embodying the views which they had only mentioned sporadically.

Previous to him, naturalists, giving more particular attention to human anatomy, recognizing only forms, and regarding each new form as a new organ, had multiplied details infinitely without discovering any general law. "The first step toward rising to the ideal type of a vertebrate animal," says M. Flourens, in his eulogy before the Academy, "was to get free from every preconception in favor of human anatomy, as the only means of being able to regard the organs under their more general conditions, aside from the merely relative considerations of form, volume, and use." Geoffroy was convinced that identities can bear only upon relations, and had in this rule, which he called the *principle of connections*, an infallible guide through all metamorphoses, capable of unmasking the most strangely disguised affinities. Thus, whenever two parts agreed in having similar relations and dependencies, they were analogous. With this precept, Geoffroy was able to declare that the materials found in one family exist in all the others, and to proclaim his law of unity as a law of nature. In his second volume he extended the application of his principle to the formations called monstrosities, which he declared were not original anomalies, but simply cases of abnormal or of incomplete development of some particular part.

As long as the principle of unity was applied simply to vertebrates it was incontestable, and excited no contradiction; but when Geoffroy Saint-Hilaire began to extend it to invertebrates he encountered a vigorous adversary in Cuvier, whose work it had been to emphasize the distinctions between the groups which his former patron was trying to reduce to unity. When Geoffroy, in 1820, brought the articulates under his general type, Cuvier uttered words of impatience and disapproval; but, when in 1830 he proposed to include the mollusks, the long latent contention broke out. "Never," says M. Flourens, "did a more vital controversy divide adversaries more resolute, more firm, or who had by long preparation provided themselves with more resources for the combat, and (if I may say it) more learnedly prepared not to agree."

The division spread and extended to all countries where any thought was given to the subjects under debate. Geoffroy was highly applauded by Goethe, who declared the discussion a very important one for science, and made it the subject of the last lines he ever wrote. The controversy was resumed in 1832, and terminated only with the death of Cuvier. Geoffroy sometimes appeared overcome by the ability and brilliancy of his antagonist, but he never gave up, and time has rendered its verdict that, on the essential points, he was not in the wrong.

The Revolution of July occurred in the midst of the discussions in the Academy, and Geoffroy, who sympathized with the popular movement, again distinguished himself, as he had done in the previous Revolution, by an act of hospitality to the clergy, in giving shelter to the Archbishop of Paris, who was in danger of violence.

When Cuvier died, every one hastened to sound the praises of the genius of the great anatomist. Geoffroy ventured upon a criticism of his views on fossil remains and regarding the revolutions of the globe, and was accused of attacking the fame of his late antagonist. Deeply wounded at so unjust an imputation, he gave up the work that had provoked it, saying: "It would perhaps be best to have courage or wisdom enough to pay no attention to such objections. But the question now concerns one of the glories of France, the first zoölogist of our age. It is for posterity, if it deigns to concern itself with the strifes of this period, to do justice to my adversaries and myself." He was stricken with blindness in July, 1840, and with paralysis a few months afterward. He endured the infirmities of old age with great resignation, and preserved to the last the serenity of a good man and a great mind—or, as Edgar Quinet remarks of him, "he approached unveiled truth with a cheerful face, and descended without fear into eternal knowledge."

The list of the works of Geoffroy Saint-Hilaire would be a very full one if all were included. Besides the larger works which he composed, or in the composition of which he was associated, the catalogue of the principal only of the papers he presented to learned societies occupies a full page in the "Biographie Générale." His most important publications are the "Philosophie Anatomique" (2 vols., 1818–1820), which contains the exposition of his theory; "Principles de la Philosophie Zoölogique" ("Principles of Zoölogical Philosophy," 1830), which gives a synopsis of his discussions with Cuvier; "Études Progressives d'un Naturalist" ("Progressive Studies of a Naturalist," 1835); "Notions de Philosophie Naturelle" ("Ideas of Natural Philosophy," 1835); and, in conjunction with Frédéric Cuvier, "Histoire Naturel des Mammifères," ("Natural History of Mammals," 3 vols., 1820–1842). Among the best works about him are the "Life," by his son Isidore; the "Eulogy," by M. Flourens; and a sketch in the appendix to De Quatrefages's "Rambles of a Naturalist."

CORRESPONDENCE.

SCIENCE IN CLASSICAL SCHOOLS.

Messrs. Editors:

PROFESSOR COOKE, in his remarks on "The Greek Question," does injustice to the best classical schools in express terms, and his statements ought not to pass unchallenged. Classical culture as preparatory for any of the "learned" professions, literary or scientific, needs no defense. But Professor Cooke, if he knew the facts, should not have held up foreign universities as wholly successful in the change he proposes. He should not have said that "among others the University of Berlin, which stands in the very front rank, has already conceded, to what we may call the new culture, all that can reasonably be asked." Is it not true that these concessions were made against the unanimous protest of all the faculties; that, after earnest comparison of the progress of scholars from the Realschulen and the Gymnasia, the scientific professors are unanimous in their demand that classical training shall be restored even for those intending to enter scientific professions?

Professor Cooke, mentioning by name certain well-known classical schools, tells us that "the attempt to introduce some science requisitions into the admission examinations has been an utter failure"; that "the science requisitions have been simply crammed, and the result has been worse than useless"; that "it has, in most cases, given a distaste for the whole subject"; that "true science-teaching is utterly foreign to all their methods"; that "the small amount of study of natural science which we have forced upon them has proved to be a wretched failure, and the sooner this hindrance is got out of their way the better"; that it is hopeless to look for any change in the classical schools. These are heavy charges, if true; but do they represent the facts?

Harvard College was among the first to shake off old methods, and to introduce a system of examinations which should distinguish between those applicants who had been crammed and those who had been taught. Her professors have showed themselves able to set papers in all branches, which proved those admitted worthy to join her classes. Professor Cooke would probably not admit that his colleagues in the scientific departments have been behind their classical associates in this respect. What, then, has been the record of the Roxbury Latin School in the six years that boys have been presented in Physics? Though every boy has been allowed to try the examinations in Physics, even if we judged him deficient, only two have been rejected out of above eighty presented. In one year, out of fifteen boys presented, sixteen honors were taken in subjects purely scientific, viz., seven in Prescribed Mathematics, two in Prescribed Physics, one in Prescribed and Elective Physics, and six in French.

It is certain that many of those eighty boys have not been crammed, and that few of them have gained "a distaste for the whole subject." For, though the time for the subject has been limited, and the apparatus meager, I have seen them eagerly making apparatus to illustrate their lessons, and discussing, at every opportunity, disputed points. In one instance three boys worked for weeks on a machine to prove their teacher in the wrong, while nearly the whole class enthusiastically supported their mates with sincere but mistaken conviction.

Perhaps one ought to speak modestly about true science-teaching being foreign to all his methods, but I will say that the trustees, taking advantage of a slight change made necessary by the rejection of Arnott as a standard of preparation, and of a fine addition to our building, have fitted up a working laboratory for our physics, and have furnished suitable apparatus. Then every boy of my present class, aided only by a paper giving directions for manipulation, is performing every experiment for himself, is putting his questions to Nature, recording and interpreting the phenomena observed.

We do not regard the study of science as forced upon us. For years before any science was required a good portion of two years was given, and still is given, to the study of botany, though our boys are not presented in that subject. And the authorities of this school are so thoroughly in sympathy with the advancement of science that, whether physics shall be required by Harvard or not, more and not less time is likely to be given to its study in the future.

With centuries of testimony for the "old classical culture," testimony unshaken by repeated assaults, of course the social prestige of our classical schools and universities holds its own. Of course, parents wish their sons fitted for and trained by classical colleges. Of course, "nine, at least, out of every ten, offer maximums in classics," and continue as they have begun.

But, when Harvard is ready to remove Greek from the list of prescribed subjects, I believe that many classical schools will be found liberal enough to give pupils every opportunity to replace its study with German, mathematics, and science, taught by men both competent and sincere.

GEORGE F. FORBES,
Master in Roxbury Latin School.

ROXBURY, MASS., *November* 14, 1883.

THE HOME-MADE TELESCOPE.

Messrs. Editors:

WHILE reading the very useful article in the November issue of the "Monthly," by Dr. George Pyburn, on "A Home-made Telescope," it occurred to me that my own experience in that direction, not covered by Dr. Pyburn's article, might prove acceptable to some of your readers. In constructing my telescope I made the tube of paper and paste substantially as described by Dr. Pyburn, finishing with shellac-varnish as a protection against moisture. The three-inch object-glass cost about twenty-five dollars, which is nearly the total outlay for the instrument, as I use for eye-pieces those belonging to my microscope. As these range from a two-inch to a four-inch, I get a fair astronomical telescope with powers from twenty-five to two hundred diameters, affording satisfactory views of the more interesting celestial objects. For viewing the sun, a light box open on one side is attached to the tube, containing a sheet of white paper on which the image of the sun is received at a distance of nine or ten inches from the eye-piece. The stand is unskillfully constructed of wood, but, as the instrument is supported at two points, it is steady. It is of convenient height for an observer in a sitting posture, the object-end of the telescope being made to swing. When in use the telescope is strapped in a kind of long trough made by nailing two strips of boards together. This support is bolted at the end next the observer to an axle having a vertical motion. It has a horizontal motion on the bolt. The end of the support toward the object is given a vertical motion from horizontal to perpendicular by a lever running through a mortice in the stand, and working on a pin in the mortice. A rod jointed on the lower end of the lever is always in reach of the observer with which to manipulate it. The top of the lever is fitted with a long horizontal roller, on which a roller placed under the telescope-support rests at right angles. The rollers crossing each other at right angles, smooth and steady motion is had both vertically and horizontally. Such a stand may be made in a day.

GEORGE W. MOREHOUSE.

WAYLAND, NEW YORK, *October* 29, 1883.

INSECTS AS CARRIERS OF DISEASE.

Messrs. Editors:

ALTHOUGH not prepared to accept entirely the theory so ably presented by Dr. King, in the September number of your magazine, as to the mosquital *origin* of malaria, I believe in the power of insects to transmit and disseminate infectious diseases. The active agency of mosquitoes and other insects in the spread of yellow fever has never been fully appreciated, and it is to be hoped that the attention of the boards of health in the localities liable to this terrible scourge will be directed to this source of danger, and that they will establish cordons of fires as well as men around infected districts. However, my object in writing this is merely to add further testimony as to the fact of insects carrying disease.

The interior counties of the Southern States are infested by a minute fly, a little larger than the sand-fly of the coast, but without the sting of the latter. They are called gnats or black gnats, and are exceedingly troublesome, from their habit of flying into the ears and eyes of both men and animals. They also gather upon any running sore or abrasion of the skin, and, though they do not bite or sting, they are very irritating. When they get into the eye they cause a very sharp pain, and, though immediately killed by the secretions, the eye feels the effects for some hours after. It has been observed that during the seasons when these gnats are most plentiful the disease known as sore-eyes is most common and severe.

Not being a physician, I do not know the name of the disease, but it is very contagious, and usually affects an entire family when once introduced into it. The lids of the eye become irritated and swollen, and the entire ball is red and inflamed. Some persons have lost the sight of one or both eyes from it, and its effects are felt for months after recovery. The intimate relation existing between this disease and the gnats is so well recognized that the negroes say it is caused by the gnats laying their eggs in the eye. This, of course, is improbable, but points clearly to them as the real cause in some way. I do not think the irritation arising from their getting into the eye is the origin of the trouble, because the disease does not always or even generally follow as a matter of course; but I do think that the germs are carried upon the legs or wings of the gnats, and that, when one so charged touches or gets into the eye, the germ or bacteria is deposited, and from that the disease is developed.

Of course, there are other ways of transmitting the disease, but the most active agent is undoubtedly the gnat, since after it disappears the disease ceases to spread, and gradually loses its character as an epi-

demic. If through your published articles intelligent observation is directed toward the dangers inherent in our insect pests, and means are discovered to avert them, you will deserve the undying gratitude of suffering humanity.

Respectfully, A. G. BOARDMAN.

MACON, GEORGIA, *September* 22, 1883.

TIDAL ANOMALIES.

Messrs. Editors:

PROFESSOR R. W. MCFARLAND ("Popular Science Monthly," volume xii, page 106), after demonstrating, as a result of Professor Schneider's theory, a great inequality in the daily range of the tides, confidently asks, "Do your New York tides play such tricks?"

However it may be with the New York tides I will not undertake to say, but there are numerous localities upon the globe where the tides do play such or at least similar "tricks," seemingly at variance with established theories, and in some places these "tricks" appear to be contrary to all our preconceived notions of hydrodynamics. Thus, at the entrances of the various United States ports in the Gulf of Mexico, the tides either exhibit a great inequality in their daily range, or but one flood and ebb tide occurs in the course of the twenty-five hours usually occupied by the two tides. The one-tide phenomenon is again met with among the Philippine Islands; while tides exhibiting considerable daily inequality in their range are met with in numerous other places.

That part of the St. George's Channel called the Irish Sea included between the fifty-third and fifty-fifth parallel of latitude contains a body of water covering an area of about ten thousand square miles, inclosed on all sides, except at the two entrances, north and south of Ireland. Throughout this entire body of water the time of high water is nearly simultaneous, the difference nowhere exceeding an hour. Here the average mean range of the tides is not less, probably, than twenty feet. The water to supply and exhaust this broad area of unusually large range of tides has to pass in and out at the two entrances simultaneously with the rise and fall of the water in the Irish Sea.

Now, the puzzling thing about these tides is, owing to the time of high water at the two entrances being about five hours earlier than in the Irish Sea, at least two thirds of all this water passing in and out of the St. George's Channel has the appearance of running from a lower to a higher level. Here the tides exhibit another curious freak in the distribution of their range. On the east coast of Ireland, between Wexford and Wicklow Head, for some distance there are no rise and fall to the tides; while directly on the opposite side of the channel, on the coast of Wales, the mean range is not less than fifteen feet.

But this anomaly of the water apparently running up-hill, as exhibited by the tides, will be found more clearly marked at the Strait of Gibraltar, where the motion of the tidal wave is easterly, and the easterly tidal stream begins at high water, and the westerly tidal stream begins at low water. The same phenomenon is met with again at the Strait of San Bernardino, Philippine Islands, and also on our own coast, in Martha's Vineyard Sound, where the motion of the tidal wave is westerly, and the westerly tidal stream begins at high water. At Cook's Strait, New Zealand, the motion of the tidal wave is westerly, and the westerly stream begins at half flood.

These are only a few of the more clearly marked of the many anomalies that have come under my observation while endeavoring, as a navigator, to make myself acquainted with the concrete phenomena of the tides.

In the absence of a better explanation of these anomalies, I offer the following hypothesis: *That the established theory of the tides is substantially correct; but, that the primary tidal wave is in the liquid portion of the earth beneath the solid (though to a greater or less extent flexible) crust; and that the tidal phenomenon as it reveals itself to us is a secondary tidal, undulatory motion, deriving its impulse from, and is complicated by, the variable flexibility of the solid crust between the two liquid portions of the earth.*

GEORGE W. GRIM (Bark Coryphene).

YOKOHAMA, JAPAN.

ELEPHANTS' TRICKS.

Messrs. Editors:

THE following extract from an old edition of the "Arabian Nights" (Edinburgh, 1772), may be of interest, showing as it does that at an early date elephants were trained to perform tricks which excite the curiosity if not the wonder of the spectators in the modern shows. It is from the story of "Prince Ahmed and the Fairy Pari-Banou":

"But what the Prince Houssain most of all admired was the ingenious address and invention of some Indians, to make a large elephant stand with his four feet on a post which was fixed into the earth, and stood out of it above two feet, and beat time with his trunk to the music. Beside this there was another elephant as big as this and no less surprising; which being set upon a board which was laid across a strong rail about ten feet high, with a great weight at the other end which balanced him, kept time by the motions of his body and trunk as well as the other elephant, and both in the presence of the king and his whole court."

When this story was written I do not know, as this edition gives no notes as to the original sources of the stories.

Respectfully, DAVIS L. JAMES.

CINCINNATI, *October* 6, 1883.

EDITOR'S TABLE.

"CHURCH-AND-STATE" FUNCTION OF DEAD LANGUAGES.

THE partisans of classical studies had a Godsend a couple of years ago, in the shape of a report emanating from the professors of the University of Berlin, and corroborated by the action of other universities, which it was claimed ended the controversy on the question of modern against classical studies. It was represented that the Germans had tried out the issue in the fairest way, and on an extensive scale. They had two systems of schools which prepared young men for the universities —one the gymnasiums, devoted mainly to classical studies; and the other the real schools, modern in origin, and devoted chiefly to modern and scientific studies: and it was said that, after an ample trial of the two modes of mental preparation, the unanimous verdict of the faculty, including the scientific professors, was in favor of the classical preparation as superior to the scientific preparation of the young men. The statement as it appeared was very telling. The New York "Evening Post" gave an account of the report soon after its appearance, and said: "It will hardly fail to be regarded as the most powerful plea ever made in behalf of classical studies," and Mr. Charles Francis Adams, Jr., has been reproached from all the classical quarters for venturing to open his mouth in criticism of our dead-language studies after the German universities had given to the world their conclusive judgment upon the question.

We confess to having had no little distrust of the case as it was thus presented. It was sufficiently obvious at the time that we were not in possession of all the facts necessary to form an intelligent opinion on its merits. We know enough of the spirit and tactics of the classical party, in this country and in England, to justify some suspicion of the impartiality of their proceedings in Germany, and we accordingly deferred any discussion of the Berlin report until more information should become available for the purpose. Many questions arose of decisive significance to which answers could not be obtained, and it seemed futile to debate a question while in the dark regarding its most important conditions.

But the information wanted is now forthcoming, and it well pays for waiting. An American gentleman, both interested in the subject and very competent to investigate it, himself a cultivated classical scholar and educated in Germany, has made the subject a matter of special and careful inquiry, and gives the result in the opening article of the present "Monthly." He has been in Germany during the past year, expressly to study certain aspects of its university system, and has visited a large number of its great educational institutions, and conversed with many of the professors in relation to the nature and actual significance of the real-school controversy, and the action that has been taken upon the subject. The Berlin report is also itself published in English by Ginn & Heath, of Boston, so that both sides of the case are now open to all who care about the question. Those who read the paper of Professor James—and none can afford to pass it by—will find that the uses to which that report has been put in this country are entirely unjustifiable. It turns out, as we suspected, that there is a good deal more to be taken into consideration than has been represented, and that the German document is a thoroughly one-sided affair.

We have to remember, in the first place, that partisanship on this question

runs very high in Germany, and that the reports against the real schools were all written by prejudiced classical extremists. It turns out, moreover, that the whole question was decided upon in advance, and with the greatest emphasis, before the experiment had been tried to test the preparation of the real-school graduates, and that from the outset the problem was not that of the progressive principles of higher education, as we understand it in this country, but a question of national politics in relation to the policy of the universities. The historic ascendency of dead languages, as against the rising claims of science, is to be maintained in Germany for state reasons. This is no mere inference, but the bluntly declared position. When the matter was first broached, in 1869, of admitting the real-school graduates to the universities, the Philosophical Faculty of the Berlin University protested vehemently against the contemplated action on the grounds here stated. They said: "While the university has no reason to withhold its advantages, it must not, in its desire to make the higher education accessible to the greatest possible number, forget its peculiar purpose and its historical task. Its duty is to fit the youth for the service of state and church." Again: "The faculty are compelled . . . to utter a warning against the surrender of that which has been till now the common basis of training of all the higher public functionaries, and which, if it be once given up, can never be regained." And still further: "The Philosophical Faculty can not give their consent to such a movement. They are convinced that no sufficient compensation is given in the real-schule for the lack of classical education. They fear that so decided a lowering of standards would be accompanied by weighty consequences, especially in such a state as Prussia." And finally, "The faculty, therefore, believe they owe it to the university and to the state to declare themselves in the most positive manner against a more extensive admission of Realschüler."

These statements give us the key of the celebrated "Berlin Report." A despotic paternal government has church-and-state reasons for maintaining a dead-language culture as a national policy. The whole vast machinery of education in that empire is run in subordination to the ideal of government—a military despotism, and, to discipline a community into thorough subjection to this ideal, centuries of history prove that there is nothing equal to the dead languages and classical studies. Hence the traditions must be maintained in their full rigor, the existing faculties must not be divided, science must not be suffered to take a coequal place with the other faculties, or to become an independent power in the universities; in short, no rival system of organized higher education, based upon modern ideas, must be tolerated.

The whole question was thus prejudged and predetermined, and no experiment that could possibly be made under the Bismarckian *régime* would be allowed to disturb the foregone church-and-state conclusion of the Berlin Philosophical Faculty. The real-school graduates were, however, admitted to the university, and after ten years it was, of course, reported by the same faculty that the policy pronounced bad at the outset was bad at the end. The real-school graduates were declared failures, as they must have been failures by the church-and-state standards assumed, whatever their proficiency. That the teaching in the real schools was inferior to that in the gymnasiums was allowed no weight; that the gymnasiums were pets of the Government and the real schools neglected was of no importance, that the brightest youths and the best stock of Germany crowded into the gymnasiums, leaving the lower grades to the real schools, amounted to nothing; and that the system of study in the real schools had not been shaped as a preparation for higher university work,

as was the fact with the gymnasiums, counted for naught. It was only said that the graduates of the gymnasiums beat the graduates of the real schools, when tested side by side in the university.

We venture to think that "the most powerful plea ever made in behalf of classical studies," when viewed in the light of Professor James's exposition, will be seen to disclose the customary weakness of all the defenses of the classical superstition, besides being for imperative considerations wholly inapplicable in this country.

LEARNING ONE LANGUAGE BY STUDYING OTHERS.

THAT fine classical scholar, and accomplished master of both prose and poetic English, Walter Savage Landor, in his "Letters to an Author," observed, "If we wish to write well, we must keep our Greek and Latin out of sight." We shall not undertake to say what or how much Landor meant by this remark, but he could not have signified less than that the influence of those dead languages may be bad upon an author who strives to attain a high standard in his native tongue. The implication is that the vernacular must be itself and independently cultivated without interference from foreign influences. Obviously skill and perfection in any art can only come from careful study and patient practice of that art, and not by studying any other art. The acquirement of a language for its highest purposes, to become a powerful and perfect instrument for the expression of thought in any of the nobler forms of literature, is the most transcendent of the arts, and the utmost excellence in it is not to be achieved through the study of another language. Genius, perseverance, and an everlasting apprenticeship are required to develop even partially the resources of any vernacular tongue, and, by the laws of all human effort and human success, there must be undivided concentration upon the instrument to be mastered. The Greeks, as we have before had occasion to state, were shut up to this condition, and, by not scattering their efforts upon other languages, carried their own to a high degree of perfection. But in these times, when there is such a passion to become familiar with many languages, there is a corresponding neglect of the vernacular, and no end of crude, incompetent writing is the result. We are told perpetually that perfection in English is to be achieved through familiarity with the ancient classical models; or, in other words, to get the completest command of our own speech, it is necessary first to know the Greek and Latin languages. This stereotyped dictum is equally a violation of common sense, out of harmony with the open facts, and in the teeth of weighty authority. It is simply notorious that a great number of the finest masters of English in different departments of literature knew little or nothing of Greek and Latin, and acquired their proficiency in English by the direct cultivation of it. And that competent classical scholars may be, and often are, incompetent in English, is strongly affirmed by many who have the best opportunities of knowing. An able English scholar, Mr. Dasent, who had large experience as an examiner of classical students, says: "I have known young men who write very good Latin prose indeed, and very good Latin verse. I know what good Latin prose and Latin verse is, and I have known the same young men utterly incapable of writing a letter or a decent essay in their own language." And, again: "I think I know good writing when I see it, and I must say that some who had great classical reputation have been the worst English writers I have known. I have observed this over and over again. I have known men recommended solely in consequence of their university reputation, and I have found that they have been signal failures in English writing—splendid scholars, but utterly incapable of expressing themselves in their own tongue. They have no choice of words,

and very often have a heavy, cumbrous way of expressing themselves."

But the most striking exemplification of this principle on a grand scale is probably now to be found in Germany. From the article of Professor James we gather that the dead-language superstition holds on in that country with the greatest inveteracy. Dead languages are the center and pivot of the national system of education, maintained with unrelenting tenacity in all the favorite government institutions of culture, the trade-mark of social position, and the gateways to all honor and emolument. In the official preparatory schools, the gymnasia, twice as much time and labor are given to Latin and Greek as in our own colleges. Certainly here, if anywhere, we should observe the general reflex advantages upon the vernacular speech of life-long intercourse of the cultivated German mind with the classical masterpieces. If the study of dead languages can perfect a living language, then surely the German language should have become the world's model in every desirable attribute, and German books should be taken as the world's standards of the finest lingual achievement. If the virtues of grinding in Latin and Greek are so great as they are alleged to be, German writing should be the type of lucidity, elegance, conciseness, and force of expression. But such are not the characters for which the German writers are usually distinguished. They are the worst expositors in the world, and the national habit is so careless and slovenly that it is recognized even by some German writers themselves as a national reproach. Professor Helmholtz translated a series of works into German, among other reasons for the avowed purpose of doing something to raise the standard of clearness and simplicity in the use of the German language. These works, offered as exemplars, were not from the treasures of Latin and Greek, but were from a living language, the English, and by a writer, Professor Tyndall, who had attained his remarkable mastery of the native tongue by the critical study of it, and not by the study of dead languages. The following extract from an editorial in "Science" of October 5th sufficiently illustrates the literary habits and general state of mind of a people trained beyond any other people in the old languages of Greece and Rome:

> In German scientific writings the excellence of the matter usually contrasts vividly with the defective style and presentation. Indeed, the Germans, despite the superiority of their modern literature, are awkward writers, and too often slovenly in literary composition. Conciseness and clearness are good qualities, which may assuredly be attained by the expenditure of thought and pains; but these the German investigator seems unwilling, in many cases, to bestow upon his pen-work, but follows the easier plan of great diffuseness. Besides this, another defect is not uncommon—the ill-considered arrangement of the matter. This occurs in all degrees, from a well-nigh incredible confusion (to be sometimes found even in elaborate and important essays) to a slightly illogical order. In this regard, a curious and not infrequent variety of this fault deserves mention. According to the headings of the chapters or sections, the division of topics is perfect; but under each head the matters are tumbled together as if a clerk was contented to stuff his papers in anyhow, if only he crammed them into the right pigeon-hole. Speaking broadly, the German mind lacks conspicuously the habits of clearness and order. There have been celebrated exceptions, but they were individual. The nation regards itself as having a decidedly philosophical bent, meaning a facility at taking broad and profound views of the known. We venture to contradict this opinion, doing it advisedly. Their profundity is mysticism, their breadth vagueness, yet a good philosopher must think clearly. It is a remarkable but little-heeded fact, that Germany has not contributed her share to the generalizations of science; she has produced no Linné, Darwin, Lyell, Lavoisier, or Descartes, each of whom bequeathed to posterity a new realm of knowledge, although she has given to the world grand results by the accumulated achievements of her investigators. The German's imperfect sense of humor is another obstacle which besets him on every path. He is cut off from the perception of some absurdity, like that of Kant's neumenon, for instance. One can not explain this

to him; it were easier to explain a shadow to the sun, who always sees the lighted side. To state the whole epigrammatically, German science is the professional investigation of detail, slowly attaining generalization.

LITERARY NOTICES.

THE LAW OF HEREDITY. A Study of the Cause of Variation, and the Origin of Living Organisms. By W. K. BROOKS, Associate in Biology, Johns Hopkins University. Baltimore: John Murphy & Co. Pp. 336.

THIS work combines in a very unusual degree the two traits that are so rarely found to coexist in scientific books: it is both original and independent in its views, and is at the same time a most lucid and popular presentation of its subject. While the work is as far as possible from being a compilation, and will be sure to take its place as a valuable contribution to philosophic biology, the author has, nevertheless, given us such a survey of the general subject as will prove interesting and instructive to all readers. We needed a good exposition of the nature and present condition of the fundamental problems of heredity, and we here have it by one who has labored systematically and effectively in the direction of their solution; and what is perhaps still more to the purpose, we have it in the light of a new and advanced theory of the subject of extreme interest, and which will probably prove a permanent and valuable contribution to the inquiry.

Dr. Brooks devotes his first chapter to the question, "What is heredity?"—and he gives his readers a vivid idea of the marvels which it involves. Of course, people who have no real or accurate knowledge on the subject of life are but ill prepared to appreciate its subtilties, and our author observes that such people are apt to "regard an adult animal with feelings similar to those with which an intelligent savage might regard a telephone or a steamboat. . . . A dog with all the powers and faculties which enable him to fill his place as man's companion is a wonder almost beyond our powers of expression; but we find in his body the machinery of muscles and brains, digestive, respiratory, and circulatory organs, eyes, ears, etc., which adapts him to his place; and study has taught us enough about the action of this machinery to assure us that greater knowledge would show us in the structure of the dog an explanation of all that fits the dog for this life—an explanation as satisfactory as that which a savage might reach in the case of the steamboat by studying its anatomy. . . . Let our savage find, however, while studying an iron steamboat, that small masses of iron without structure, so far as the means at his command allow him to examine and decide, are from time to time broken off and thrown overboard, and that each of these contains in itself the power to build up all the machinery and appliances of a perfect steamboat. The wonderful thing now is, not the adaptation of wonderful machinery to produce wonderful results, but the production of wonderful results without any discoverable mechanism; and this is, in outline, the problem which is brought before the mind of the naturalist by the word heredity. . . . In the mind of the naturalist the word calls up the greatest of all the wonders of the material universe: the existence in a simple, unorganized egg, of a power to produce a definite adult animal with all its characteristics, even down to the slightest accidental peculiarity of its parents—a power to reproduce in it all their habits and instincts, and even the slightest trick of speech or action."

Dr. Brooks then proceeds to state various other striking and subtile phenomena involved in heredity, and then intimates that, notwithstanding their refinement and obscurity, they are unquestionably capable of being cleared up so as to be as fully understood as other scientific laws. He says: "We may not be able as yet to penetrate its secrets to their utmost depths, but I hope to show that observation and reflection do enable us to discover some of the laws upon which heredity depends, and do furnish us with at least a partial solution of the problem; that we have every reason to hope that in time its hidden causes will all be made clear, and that its only mystery is that which it shares with all the phenomena of the universe."

Chapter II, on the "History of the Theory of Heredity," is of extreme interest. He traces the most notable speculations upon the subject that have been made in past times, and points out their inadequacy

both from defective knowledge and from erroneous views of the nature of life, and shows that no explanations of the phenomena could be at all satisfactory until biology had fully accepted and broadly planted itself upon the evolution hypothesis. Dr. Brooks's summary in this chapter of the fundamental facts that have been established in this field of inquiry, and which he presents as requisites of a theory of heredity, is very discriminating and helpful in the prosecution of the inquiry. In Chapter III the same line of historic analysis is pursued more closely, and the author is here brought to the consideration of Darwin's theory of pangenesis, one of the latest forms of the explanation of hereditary phenomena. Dr. Brooks finds the hypothesis of Darwin to be unsatisfactory, in that it does not recognize such a difference in the functions of the reproductive elements of the opposite sexes as the facts require and now seem to warrant. And, after his review of the various theories that have been thus far offered, our author then proceeds to the main thesis of his work, which is the establishment of a new theory of heredity based upon the different powers and functions of the respective reproductive elements.

It will not be possible here to give any full or satisfactory account of Dr. Brooks's theory as elaborated and illustrated in the volume before us, nor will it be so necessary to the readers of the "Monthly," as Vol. XV of this magazine contains two articles upon the subject by the author representing his views, and exemplifying some of their higher applications. It may be stated, however, that while Darwin holds that male and female give equal elements in their combined offspring, Dr. Brooks maintains that they are not only different, but that the difference rises to the import of a general law. While the function of the female is conservative, or to preserve and hand on all the parts that belong to the race—all that has been acquired, with little or no tendency to vary from the race type—on the other hand, the male, leading a more varied and adventurous life, stamps the tendency to variation, the impulses to higher development, upon the common product of organization. There is more than plausibility, more even than probability, in this idea, and those who look critically into the evidence adduced by the author can hardly fail to recognize that he has seized upon an important principle in this field of investigation.

THE ENGLISH GRAMMAR OF WILLIAM COBBETT. Carefully revised and annotated by ALFRED AYRES. New York: D. Appleton & Co. Pp. 254.

"'COBBETT'S GRAMMAR,'" says the editor of this edition, "is probably the most readable grammar ever written. For the purposes of self-education it is unrivaled." This is probably because it is not strictly a grammar according to the common ideas of a grammatical text-book, but is rather a series of familiar, practical letters on the use of the English language. Technicalities are absent, and paradigms are rare, and given only in illustration of the discussions of the text. The editor's work has been chiefly to call attention to the points in which Cobbett's teachings differ from what is now considered the best usage, a matter in which changes may have occurred or more strict distinctions have been established since the first edition of the "Grammar" was published in 1818; to note the few errors of diction to be found in the letters; and to emphasize a more discriminating use of the relative pronouns than is customary in English literature. The last is a point on which the editor appears to set much store. The rule he announces on the subject is that "WHO and WHICH are properly the co-ordinating relative pronouns, and THAT is properly the restrictive relative pronoun. Whenever a clause restricts, limits, defines, qualifies the antecedent—i. e., whenever it is adjectival—explanatory in its functions—it should be introduced with the relative pronoun THAT, and not with WHICH, nor with WHO or WHOM. . . . WHO and WHICH are the proper co-ordinating relatives to use when the antecedent is completely expressed without the help of the clause introduced by the relative." The rule seems to be a useful one, other things being equal; but as we read the THATS which the editor has inserted in brackets after Cobbett's WHO's and WHICH's wherever he judges the change should be made in accordance with his rule, and as we observe in other places,

we find it will not do to establish the maxim as obligatory, but that it must be made very often to yield in favor of euphony or considerations of grace in style. One of the most commendable features in the present edition is its complete and excellently arranged index.

DAS STUDIUM DER STAATSWISSENSCHAFTEN IN AMERIKA (The Study of the Political Sciences in America). By Dr. E. J. JAMES. Jena: Gustav Fischer. Pp. 26.

THE substance of this publication was originally contributed by the author, a professor in the University of Pennsylvania, to the "Jahrbücher für Nationalökonomie und Statistik." It comprises a clear review of the present condition of the teaching of political economy and other branches relating to public polity and administration in the colleges of the United States, with specific notices of the courses in those institutions in which more particular attention is given to it.

TWELFTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES. By F. V. HAYDEN. Washington: Government Printing-Office. Part I. Pp. 809, with 154 Plates. Part II. Pp. 503, with 80 Plates and 17 Maps.

THESE volumes and the accompanying portfolio constitute the final report of the Hayden Survey, and cover the work done in 1878 and until the close of the existence of the survey, June 30, 1879. The first part includes the reports of Dr. C. A. White on Geology and Paleontology, and of Professor A. S. Packard, Jr., and R. W. Schufeldt on Zoölogy. The second part relates to the Yellowstone National Park, and comprises the "Geology" of that region, by W. H. Holmes; "The Thermal Springs," by Dr. A. C. Peale; and the "Topography," by Henry Gannett, E. M.

SEA-SICKNESS: Its Cause, Nature, and Prevention without Medicine or Change in Diet. By WILLIAM H. HUDSON. Boston: S. E. Cassino. Pp. 147. Price, $1.25.

SEA-SICKNESS is regarded in this treatise as the result of offenses against gravity, aggravated by attempts to resist them. The irregular motions of the ship are constantly displacing the center and the direction of gravity of the body and its parts, while the muscular efforts made to counteract those efforts produce other shocks. Consequently, the system becomes thoroughly disorganized. The remedy recommended is to submit to the conditions. Secure a complete relaxation of the muscles, and there will be, it is asserted, no trouble.

CUMULATIVE METHOD FOR LEARNING GERMAN. By ADOLPHE DREYSPRING. New York: D. Appleton & Co. Pp. 253. $1.50.

THE theory on which Mr. Dreyspring has worked is that of repetition. His aim is to teach the student German by the same kind of process as that by which a native learns it, and so to drill him that he shall know when a phrase is formed aright, not by having to go through the painful process of a grammatical analysis, but simply because it "sounds right." The method is then generally oral and conversational. The first stumbling-block the student in German has to meet is the "chaos," as the author well styles it, of genders. Mr. Dreyspring meets it by drilling the pupil in series of exercises on single words in connection with the articles and pronouns and some adjectives. By the time he has pronounced the word in a dozen or twenty recurrences with the adjectival terminations, *er*, *e*, or *es*, that may be appropriate to the so-called gender of the word marking as many adjectives, he will be very apt to have gained the power of detecting a wrong use at once by its sounding wrong. Drills governed by this idea are supplemented by exercises and reading-lessons, with a stock of words that is considered ample for the practical wants of every-day life and conversation; and when, the author believes, "by constant and ever-varying repetitions, these words are fully mastered, the student will possess a thorough knowledge of the practical framework of the language."

QUESTÕES HYGIENICAS (Hygienic Questions). By Dr. JOÃO PIRES FARINHA. Rio de Janeiro: Typographia Nacional. Pp. 54.

DR. FARINHA is physician to the houses of detention and correction in Rio de Janeiro. The pamphlet before us is a collec-

tion of articles which he has contributed to the "Uniao Medica" and the "Jornal do Commercio" of that city, on such subjects as "Animal Emanations," "The Sewers of Rio de Janeiro and their Influence upon the Public Health," and "Popular Counsels on Matters of Hygiene."

DANGERS TO HEALTH: A Pictorial Guide to Domestic Sanitary Defects. By T. PRIDGIN TEALE, M. A., Surgeon to the General Infirmary at Leeds. Fourth edition. New York: D. Appleton & Co. Pp. 163. Price, $3.

A MOST vivid presentation of the ills which follow in the track of the botching plumber and drain-builder is this by Dr. Teale. Convinced that pictures are more effective than words, the author depicts in seventy plates various faults of sewerage, most of them actual cases, and accompanies each with a few paragraphs of explanation or history. The course of sewer-gas is indicated by blue arrows, and the flow, the leakage, and infiltration of sewage are also represented in blue. Among the faults described are untrapped waste and overflow pipes passing directly into a soil-pipe, traps emptied by evaporation or by the flow of water past their outlets, drain-pipes of poor quality or badly joined, and drains running uphill. A particularly striking group of pictures, entitled "How People drink Sewage," shows the danger to be expected from drains passing near or over wells. Among the interesting histories is the following: "Enteric (typhoid) fever broke out in a gentleman's house, from which it spread into the village. On examination I found that the water-closet was in the center of the house, and that the soil-pipe discharged into a common stone drain running under a tiled entrance-hall. This drain was almost without fall, so much so that it had become blocked, and the sewage had found its way under the flooring of the passage and rooms. It goes to a man's heart to take up a tiled hall in order to inspect a drain. *Moral*—the drain ought never to have been placed under the hall." Some twenty additional defects are noted without plates, and methods for detecting the escape of sewer-gas are given. The book contains also some hints on ventilating houses and carriages.

HISTORY AND USES OF LIMESTONES AND MARBLES. By S. M. BURNHAM. Boston: S. E. Cassino & Co. Pp. 392, with Forty-eight Chromo-lithographs.

THE modest aim of the author of this book has been, in the absence of any work exclusively devoted to limestones and marbles known to him, to present the facts and speculations of original writers "so selected and arranged as to illustrate the value of limestones in some departments of geology, but more especially their use in the mechanic and fine arts, and their history in civilization." These stones are so abundant and so diversified, their uses are so multifarious, and they play so important a part in every field, that there is certainly room and use for a book of this kind. Mr. Burnham does not claim that he has entirely filled the vacant place. That would be more than it were possible for one compiler to do at a first effort. But he has made a creditable attempt, and has produced a book embodying a large amount of authentic information concerning limestones in all parts of the globe, and their uses in all periods of history. The first chapters are devoted to a scientific consideration of limestones, describing the different classes, the fossils so abundant in them, and of which many of them are so largely composed, and the general divisions of geological time. The more particular account of the several classes of limestones and marbles follows, beginning with those of the United States, which are grouped by "regions"—Atlantic, Mississippi, and the Rocky Mountains and Pacific coast. Other limestones are classified and described as those of British America, the West India Islands, Mexico, and South America. European stones are similarly described, by countries, as well as those of Asia, Australia, and Africa. The description of the Grecian marbles is accompanied with a few remarks on their application in Greek art; and in the later chapters are given accounts of the "Antique Marbles," "Antique Alabasters, Serpentines, Basalts, Granites, and Porphyries," "Antique Stones and Works of Art in Modern Rome," and "Antique Stones used to decorate Roman Churches." The appendix gives tabular views of the "Age and Locality of the Principal Limestones," "French Marbles," and

"Marbles of Great Britain and Ireland, Germany, etc." The chromo-lithographs give clear and brilliant representations of the color and grain of some of the finer European, African, antique, and American stones.

MUSTER ALTITALIENISCHER LEINENSTICKEREI (Patterns of Old Italian Linen-Embroidery). Collected by FRIEDA LIPPERHEIDE. First Part. Pp. 32, with 30 Plates. Second Part. Pp. 36, with 30 Plates. Berlin: Franz Lipperheide. Price, six marks each part.

THE custom of embroidering articles of household linen with designs in colored silk or wool went nearly out of vogue in the last century, but still survives in parts of Italy, and traces of it may be found elsewhere. An attempt is now made to revive it and commend it. The publication in the Berlin "Modenwelt," and afterward in books, of a collection of patterns of old German embroideries revealed a richness in beautiful specimens of art of this kind that the world was not aware it possessed. The publisher might have supplemented his collection with another, as large, of additional patterns, in the same style, but he has preferred to vary it by presenting a second one in a distinct style, the old Italian. In the German embroideries, the figure is brought out in stitch-work, while the ground is left in plain linen. In the older Italian work the opposite motive generally prevails, and it is the figure that is left plain, and is embroidered around; yet there are variations, and both styles may sometimes be found in the same piece. The Italian patterns are gracefully drawn, evenly parceled off, and always conventionalized and wholly ornamental. Some of them may be ultimately of Grecian origin, but they all come to the collectors from Italy. They seem to have enjoyed an extensive diffusion, for works in Italian stitch may be found among nearly all nationalities; and we are given in these volumes, besides the Italian and Grecian designs proper, Moroccan, Persian, and Spanish-Moorish groups, all congenial in motive, but having each traits and beauties peculiar to themselves. The designs reproduced by Frau Lipperheide are taken from authenticated specimens of from the sixteenth to the eighteenth centuries, or from Italian pattern-books of the sixteenth century. The letterpress preceding the plates furnishes full, clearly illustrated instructions for executing the work in the various stitches.

THE BERLIN REPORT.

THE QUESTION OF A DIVISION OF THE PHILOSOPHICAL FACULTY. Inaugural Address on assuming the Rectorship of the University of Berlin. Delivered in the Aula of the University, on October 15, 1880, by Dr. AUGUST WILHELM HOFMANN, Professor of Chemistry. Second edition, with an Appendix containing Two Opinions on the Admission to the University of Graduates of Realschulen, presented to his Excellency the Royal Minister of Public Instruction, by the Philosophical Faculty of the Royal Frederick William University, in the Years 1869 and 1880. Boston: Ginn, Heath & Co. 1883. Pp. 77.

THIS is the somewhat formidable title under which the celebrated "Berlin Report" on classical and scientific education appears in English. The first part of it, embracing thirty-five pages, consists of the elaborate inaugural address of Dr. Hofmann, delivered October 15, 1880, devoted to a general discussion of the policy of dividing the Philosophical Faculty of the German universities so as to create a new faculty of the natural sciences. Dr. Hofmann opposes this on various grounds, and then passes to the question as to the admission for graduates of the real schools to the university, which he resists, and which is also a part of the general question of the unity of the Philosophical Faculty. Following the address is the opinion of the Philosophical Faculty of the Berlin University, given in 1869, against the proposed admission of the real-school graduates, and then comes the adverse report of the same faculty, made in 1880, after the real-school students had been admitted. The remainder of the appendix consists of notes and extracts from various authorities confirmatory of the views taken in the reports. The pamphlet contains a preface by John Williams White, of Harvard College, giving various interesting explanations. As the subject is one of considerable prominence just now, the appearance of this document in an English form will be helpful in the discussion, and will be welcomed by many readers.

BULLETIN OF THE UNITED STATES FISH COMMISSION. Vol. I, for 1881, pp. 466; Vol. II, for 1882, pp. 467. Washington: Government Printing-Office.

THE "Bulletin" is now published by the authority of an act of Congress, in two forms, a part of the edition being distributed signature by signature as the matter is collected and put in type, while the other part is bound up at the end of the year in an annual volume. Two classes of readers are thus accommodated—those who wish to get the matter as fast as it appears, as news, and those who prefer to have it in permanent form, in bound volumes. The two volumes now before us, being the first published under the new system, contain numerous articles on a variety of subjects relating to the description, propagation, catching, habits, and care of fish, the value of which is both scientific and practical; of American and of foreign origin; and original, relating to the home observations of the agents or direct correspondents of the commission, or selected from an extensive range of living ichthyological literature, and the reports of other countries. We regret the absence of an adequate classified index to the volumes. A copious general alphabetical index is given, and an index by authors, and they should not be dispensed with; but, in a work marked by the fullness of matter that characterizes these volumes, another index seems to be needed, giving the titles of articles.

ANIMAL LIFE: BEING THE NATURAL HISTORY OF ANIMALS. By E. PERCEVAL WRIGHT, M. D. London, Paris, and New York: Cassel, Petter, Galpin & Co. Pp. 618. $2.50.

THE author of this attractive work is Professor of Botany in the University of Dublin. He has prepared his book especially in view of "that class of readers who, while they take an intelligent interest in the study of natural history, have but little taste for the technical details which would naturally form the bulk of a scientific manual on the subject. With this view, nearly two thirds of the contents have been devoted to the mammals and birds. Nevertheless, the other classes have not been neglected, but a fair degree of consideration is given to the reptiles, fishes, insects, mollusks, and the lower divisions of the animal kingdom. The book has grown to its present form out of the series of lectures on zoölogy which Dr. Wright delivered several years ago to the natural history classes of his university, and the matter of it, enriched with copious citations from travelers distinguished for their researches in natural history, has been systematized and reduced to its present comprehensive and connected form, under advantages which only long-maturing thought can confer, and which a book prepared to meet a present demand can not so well enjoy. The systematic method is faithfully followed, and the animals are described by classes, orders, families, and the other related groups, in regular order, with the scientific distinctions carefully noted, so that a clear view is given of all that comes within the scope of the work. The adaptation of the style to the mind not familiar with technical language, the beauty of the broad pages with their clean paper, sharp type, and the profusion of appropriate and excellently executed illustrations, make the work eminently pleasant and suitable to the family and to general readers, and one which should attract all the young, who have any taste in that direction, to the study of natural history.

MINERAL RESOURCES OF THE UNITED STATES. By ALBERT WILLIAMS, Jr. Washington: Government Printing-Office. Pp. 813.

THIS volume represents one of the divisions of the United States Geological Survey under the direction of the Hon. J. W. Powell. It is intended to furnish an account of every mineral, whether a metallic ore, a useful salt, a building material, or a fertilizer, that is economically mined in the United States, with notes of the localities where they are found, and estimates of the production and trade value of the stuff.

UEBER DAS GALVANISCHE VERHALTEN DER AMALGAME DES ZINKES UND DES CADMIUMS (On the Galvanic Behavior of the Amalgams of Zinc and of Cadmium). By WILLIAM L. ROBB, A. B. Berlin: Gustav Schade. Pp. 30.

THIS is the inaugural dissertation by the author, an American student, on receiving at the University of Berlin, in August last, the degree of Doctor of Philosophy.

THE PHYSICIAN'S VISITING LIST FOR 1884. Philadelphia: P. Blakiston & Co. Price, $1.

THIS, as the title implies, is a sort of annual hand-book or note-book for doctors, which now reappears in the thirty-third year of its publication. It is in a compact and convenient form, and is arranged for twenty-five patients weekly. Its dose-table has been revised to accord with the late changes in the Pharmacopœia, and has a list appended with suggestions for their exhibition. There are several other tables for ready reference, and aids for calculation, and the leaves for addresses, memoranda, etc., are arranged upon a plan at once simple and comprehensive. There are more advertisements included than it seems necessary for a physician to carry round in his pocket.

THE HANDY BOOK OF OBJECT-LESSONS. From a Teacher's Note-Book. By J. WALKER. Philadelphia: J. B. Lippincott & Co. Pp. 129. $1.25.

THIS work is intended as an aid to teachers, in furnishing them with material for their lessons, and suggestions as to the way it may be used. The matter is ruled into two columns—one, headed "Matter," containing the information to be imparted, while the other, headed "Method," is intended, not to be dogmatically adhered to, but to furnish what may serve as specimens of the various expedients to which teachers may resort. Two series of lessons are furnished. In the first series are given lessons on the animal, vegetable, and mineral kingdoms, and, in the second series, lessons on physiology, physical geography, and manufactures; besides which, each series contains a department of "Miscellaneous" lessons.

KING'S HAND-BOOK OF BOSTON. Cambridge, Mass.: Moses King. Pp. 360. $1.

THIS work is designed to describe every noteworthy feature and institution of Boston. The subjects are systematically arranged, beginning with a sketch of the history of the city, after which are described the "Arteries," the "Arms" (railroads, steamers, etc.), the "Hotels and Restaurants," the "Public Buildings," and so on, through the list. The matter is periodically revised, so as to bring the successive editions of the book up to the time of their issue. The whole furnishes a comprehensive and useful account of a very interesting city, presented in the best typographical style, with illustrations worthy of their subject.

PUBLICATIONS RECEIVED.

Johns Hopkins University. Studies from the Biological Laboratory. Professors H. Newell Martin and W. K. Brooks, editors. Vol. II, No. 3. Baltimore: N. Murray. Pp. 96.

The Geology and Topography of Iowa in a Sanitary Point of View. By P. J. Farnsworth, M. D. Pp. 12. Typhoid Fever of America: Its Nature, Causes, and Prevention. By R. J. Farquharson, M. D. Pp. 12. Hospitals for Contagious Diseases, and their Proper Location. By R. J. Farquharson, M. D. Pp. 12. Ventilation. By Justin M. Hull, M. D. Pp. 48. All published at Des Moines, Iowa, by the Iowa State Board of Health.

The Oyster Epicure. New York: White, Stokes & Allen. Pp. 61. 30 cents.

English as She is Spoke. "Her Seconds Part." New York: G. P. Putnam's Sons. Pp. 56. 20 cents.

The Antipyretic Treatment of Typhoid Fever. By G. C. Smythe, M. D., Indianapolis, Ind. Pp. 24.

Annual Report of the Kansas City Public Schools, 1882-'83. Kansas City, Mo.: Ramsey, Millett & Hudson. Pp. 157.

The Despotism of Words in Relation to Science. By Orpheus Everts, M. D., College Hill, Ohio. Pp. 8.

An Examination of Some Controverted Points on the Physiology of the Voice. By T. Wesley Mills, London. Pp. 28.

Description of a Revolving Astigmatic Disk. By Charles A. Oliver, M. D., Philadelphia. Pp. 7.

Ocean Grove Camp-Meeting Association. Fourteenth Annual Report. Ocean Grove, N. J. Pp. 76.

Experimental and Inductive Chemistry. Prospectus and Proof-sheets. By Charles R. Dreyer, Fort Wayne, Ind. Pp. 32.

Chicago Astronomical Society and Dearborn Observatory Reports, 1883. Chicago: Knight & Leonard. Pp. 15.

University of Georgia, Medical College, Closing Exercises. Pp. 4.

The Treatment of Wounds, as based on Evolutionary Laws. By C. Pitfield Mitchel. New York: J. H. Vail & Co. Pp. 29. 50 cents.

"Scandinavia: A Monthly Journal," 29 N. Clark Street, Chicago. Pp. 24. 20 cents; $3 a year.

Diccionario Tecnológico: Inglés-Español y Español-Inglés. (Technological Dictionary: English-Spanish and Spanish-English.) By Néstor Ponce de Leon. In Twelve Parts. New York: N. Ponce de Leon. Pp. 48 each part. 50 cents each.

Historical Essay on the Art of Bookbinding. By H. P. DuBois. New York: Bradstreet Press. Pp. 42.

The Evolutionary Significance of Human Character. By Professor E. D. Cope. Pp. 12.

State Asylum for Insane Criminals. Twenty-third Annual Report. Auburn, N. Y.: W. J. Moses. Pp. 40.

Calendar of American History, 1884. By Delia W. Lyman. New York: G. P. Putnam's Sons. 365 Leaflets and Index. $1.

Directory to the Charitable and Beneficent Societies and Institutions of the City of New York. New York: G. P. Putnam's Sons. Pp. 169.

Felicitas. A Romance. By Felix Dahn. New York: William S. Gottsberger. Pp. 208.

Explosive Materials. By M. P. E. Bertholet. New York: D. Van Nostrand. Pp. 180. 50 cents.

Wonders of Plant-Life under the Microscope. By Sophie Bledsoe Herrick. New York: G. P. Putnam's Sons. Pp. 248. $1.50.

A Hand-Book of Hygiene and Sanitary Science. By George Wilson. Philadelphia: P. Blakiston, Son & Co. Pp. 510. $2.75.

Manual of Chemistry, Physical and Inorganic. By Henry Watts, F. R. S. Philadelphia: P. Blakiston, Son & Co. Pp. 595. $2.25.

The Organs of Speech. By G. H. von Meyer. New York: D. Appleton & Co. Pp. 349.

Queen Victoria. Her Girlhood and Womanhood. By Grace Greenwood. New York: John R. Anderson & Henry S. Allen. Pp. 401.

The Human Body. By H. Newell Martin, D. Sc. New York: Henry Holt & Co. Pp. 355. $1.50.

Text-Book of Popular Astronomy. By William G. Peck, Ph. B. New York: A. S. Barnes & Co. Pp. 330.

Zoölogy. By A. S. Packard, Jr. New York: Henry Holt & Co. Pp. 334. $1.40.

Destructive Influence of the Tariff. By J. Schoenhof. New York: G. P. Putnam's Sons. Pp. 112.

World-Life, or Comparative Geology. By Alexander Winchell, LL. D. Chicago: S. C. Griggs & Co. Pp. 642. $2.50.

Dangers to Health. A Pictorial Guide to Domestic Sanitary Defects. By T. Pridgin Teale. New York: D. Appleton & Co. Pp. 172.

History of the Literature of the Scandinavian North. By Frederik Winkel Horn, Ph. D. Chicago: S. C. Griggs & Co. Pp. 507. $3.50.

The Natural Genesis. By Gerald Massey. New York: Scribner & Welford. 2 vols. Pp. 552, 585.

Report of the Commissioner of Fish and Fisheries, 1880. Washington: Government Printing-Office. Pp. 1060, with Plates.

A Practical Treatise on Materia Medica and Therapeutics. By Roberts Bartholow. New York: D. Appleton & Co. Pp. 738.

Report of the Commissioner of Education, 1881. Pp. 840.

Cruise of the Revenue Steamer Corwin in Alaska and the Northwest Arctic Ocean in 1881. Notes and Memoranda. Washington: Government Printing-Office. Pp. 120, with Plates.

POPULAR MISCELLANY.

Origin of the Eastern End of Lake Erie.—Mr. Julius Pohlman, starting with the hypothesis that the beds of the Great Lakes were excavated by water in pre-glacial times, has sought for the river which washed out the eastern end of Lake Erie. The discovery of the many large pre-glacial rivers, in Pennsylvania and Ohio, running into the lake-basin, explains well enough how the erosion in general has taken place. "But the most easterly of these ancient water-courses yet discovered, the Alleghany, which ran northerly past Dunkirk, does not account for the forty miles of lake-valley between that place and Buffalo, and another pre-glacial river emptying into the lake-basin near Buffalo was necessary to complete the river system which occupied and excavated the valley of Lake Erie." The maps of the lake survey show that there are no indications of rocks on the shore of the lake between the southern limit of the city of Buffalo and the Horseshoe Reef of the Niagara River, and that the land is low and level for some distance back. The northern and eastern parts of the city and the bed of Buffalo Creek are underlain by a reef of corniferous limestone, which gradually ascends toward the north. Testings that have been made during the course of excavations for canals, of the depth of this rockless land, show that no rock can be found at a less depth than eighty feet below the surface. This probable fact points to the bed, and indicates the depth of the ancient river which we are seeking for. That river could not go north or east, on account of the outcropping corniferous limestone, but "it must have taken a westerly course through the soft shales of the Devonian epoch; and if we trace an imaginary line along the deepest portion of the eastern end of the lake from this ancient valley, in a direction a little southerly of west, we can connect our pre-glacial river with the ancient outlet of the river system of the Erie Valley opposite Dunkirk, and have a fair explanation of the origin of the eastern end of Lake Erie."

The New Standards of Time.—On the 7th of October a number of the railroads of the New England States, and on the 18th of November nearly all the important railroads of the Atlantic slope and the Mississippi Valley, adopted a new system of time-standards for the movement of their trains. The object of the change was to secure a more simple and harmonious way of calculating the time at the different stations on East and West lines. Under the time-system previously prevailing, the managers of each railroad endeavored to conform to the local time of the most important stations on its line. The result of this method of accommodation was that seventy-five different standards of time, varying apparently at hap-hazard from each other, were used in operating the railroads of the United States; and it was only with

extreme difficulty that the traveler between the East and the West could keep an account of the hour. The new system which has been adopted contemplates the establishment, for the whole United States, of four principal meridians, distant from each other exactly one hour of solar time, to the nearest one of which the local time of every point in the country shall be referred. These meridians are selected so as to bear an exact relation, in even hours, with the meridian of Greenwich, whence most of the world computes its longitude. "Eastern time," to which the hour from Maine to Florida and in the region of the lower lakes is adjusted, conforms to the time of the seventy-fifth meridian, which is five hours slower than Greenwich time. Its region begins at 67½° longitude, or as near there as is convenient, and ends at or about 82½°. West of this is the region of Central time, which is governed by the time at the ninetieth meridian, and extends to longitude 97½°, including the Mississippi and Missouri Valleys, the upper lakes and Texas. The next division will conform to the one hundred and fifth meridian, and will include the Rocky Mountain region; and the next, for the Pacific coast, to the one hundred and twentieth meridian. To the east of the "Eastern time" region of the United States the maritime British provinces are expected to set their clocks by the time of the sixtieth meridian, one hour ahead of any part of the United States. As the clocks in the United States have for many years been practically regulated by the railroads, it will probably not be long before the whole country, and every interest in it, will be computing its hours so as to conform with the new standards. The movement of which this is the first and a very important practical step was begun in 1875 by the American Metrological Society, and is designed to embrace the whole world. It has been approved, in principle at least, by numerous learned societies and international associations. The complete scheme involves the division of the whole earth into time-sections of 15° of longitude, or one hour each, with standards of time determined at every fifteenth meridian; the establishment of a point where for the purposes of the monthly calendar the day shall end and the next day begin, at the one hundred and eightieth meridian from Greenwich; and a numbering, for scientific purposes at least, of the hours of the day from one to twenty-four without interruption.

Greek in the Colleges.—The "Boston Globe" says that "the Phi Beta Kappa address of Charles Francis Adams, Jr., is bearing fruit sooner and more plentifully than even he could have expected. The meeting of college presidents from nearly all the New England colleges, held in Boston the other evening for the purpose of discussing the question, indicated a very general agreement with the less sweeping of his propositions. A number of the gentlemen were ready to make a beginning of reform. Mr. Adams touched a fuse that was all ready to go off." This presents the case about as it is. The colleges were all represented at the meeting by the modern-language men, who naturally argued the claims of their department with earnestness. President Porter, of Yale, was absent, but President Robinson, of Brown, who was present, believes in the ancient languages for a foundation; and Presidents Bartlett, of Dartmouth, Carter, of Williams, and probably Seelye, of Amherst, are rather conservative in this matter. President Eliot, of Harvard, on the other hand, means to give an A. M. ultimately without regard to Greek. He hopes neither to require it in college nor in preparation, but to make modern languages an equivalent. Yale, too, proposes to require either French or German for examination, and will probably lessen its requirements of the ancient languages in order to make the preliminary work no more severe than now. The fact is, that Mr. Adams drew the attention of the country to a subject which had been receiving much consideration in the colleges, and his address will do much to hasten action in regard to the study of the ancient languages. President Eliot plans a revolution in this matter, while the other colleges will all give more attention to modern languages. At Williams, President Carter means in time to make German a required study running through sophomore year, leaving it optional the rest of the course.—*Springfield Republican.*

The March of Fever and Ague.—Dr. G. H. Wilson, of Meriden, Connecticut, reviewing the history of epidemic intermittent fever in Connecticut and other parts of New England, traces in it the evidence of a regular progress in a particular direction, and by successive advances from year to year. The advance appears to be "independent of any known or recognized influence, whether atmospheric, telluric, magnetic, or climatic, and through the most diverse conditions of surface, soil, humidity, and temperature, general and local." The direction of the movement appears to be toward the northeast; and in its invasion of Connecticut "the ague crossed, diagonally but decidedly, every one of our main rivers. Starting on the coast, west of the Housatonic, it crossed its valley the next year, but did not ascend it more than about fifteen miles in as many years. It next crossed the Naugatuck, within five miles of its mouth. The Quinepiac it first reached and crossed in South Meriden, sixteen miles from East Haven; the Connecticut at Middletown, twenty-five miles from the Sound; and the tributaries of the Thames in Coventry, forty miles from the sea." In Rhode Island, also, it entered at Westerly and passed through the State to the northeast, leaving the southeast and northwest parts unaffected. The northeast course was pursued during fifteen years, or till 1875, when the malarial influence had reached Windsor, on the Connecticut. After that time, the radiation, or lateral spread of the disease, became more decided, and it finally covered every town in the State, passing the line of Massachusetts at Agawam in 1878. In the next four years it had attacked all the towns in Western Massachusetts, and a few scattered over the eastern part of that State, and had invaded Vermont and New Hampshire, as well as Rhode Island. "It is not too much to suppose that it came over from Long Island and New Jersey, and possibly farther south, as well as from the same region over Westchester County; that its front extends from the Hudson on the west to Buzzard's Bay on the east; that it has moved a hundred miles north and east, and still reaches out its favors to those belated north-men and down-Easters who have hitherto mocked us."

Hygiene in Schools.—An article on this subject in "The Sanitary Record," by John W. Tripe, M. D., contains the following: "Children are now taught, in public, elementary, and other schools, a number of facts concerning the rivers, mountains, coasts, etc., of foreign countries, and many other things which do not immediately concern them, while the merest outlines of the relations existing between the blood and the various organs of the body, and of the changes occurring therein, rarely form any part of their education. It is not necessary to tell children about the size of the liver, the average weight and muscular power of the heart, the diameter and length of the great vessels of the body, the structure of the eye, or any other similar facts; but surely it would be better for children, at any rate in the advanced classes, to be taught as to the action of fermented liquors on the system, and on the organs by which they are excreted from the body, the injuriousness of excesses in eating and drinking, and such like facts, than commit to memory a mass of information which they forget almost as soon as learned. They would also be the better for being instructed in the relations that exist between health and the social habits and customs of those among whom they will pass their lives. They might also be told the reasons why high-heeled boots, constricted waists, unwashed skins, accumulations of refuse, and many other things, are injurious to health as well as opposed to comfort."

How Buzzards find their Prey.—On the debated question as to the particular sense by which turkey-vultures are directed to their prey from great distances, Mr. Samuel N. Rhoads brings strong evidence in the "American Naturalist" in favor of the sense of smell. In digging some sweet-potatoes, he partly uncovered a spot where a horse and cow had been buried some years before. In a few hours afterward the spot became the center over which buzzards hovered by scores, during the whole of the following day, and less numerously for several days afterward. It was a strangely interesting spectacle, he says, "to behold them swoop within a few feet of the horse-hades, and rise again with slow, reluctant flaps,

indicative of disappointment, then return to deliberately 'beat' and 'quarter' the ground aërially speaking, with all the tact and persevering sagacity of their canine compeers." Gosse relates an instance that occurred in Jamaica, where vultures circled around a house in which some meat had been allowed to spoil, though they could detect nothing by sight. The smelling power which enables them thus to detect their prey must be very delicate; for Mr. Rhoads could not detect any taint in the atmosphere while he was working over the burial-place. Doubtless the birds also use their eyes, but these instances prove that the olfactory sense alone is sufficient to guide them.

Pond-Mud as a Diarrhœa-Breeder.—A fact is related in the report of the State Board of Health of Connecticut that illustrates the effect upon health of exposing the bottom of a pond. A small village in the town of Union was situated close upon the borders of a pond that was drawn down entirely during the summer and fall, for several years in succession, in order to get the water from another pond lying above it and communicating with it. When the pond was first drawn down, while the decaying materials at its bottom, which probably extended over twenty or thirty acres at least, were drying, offensive odors were complained of, and it was stated that they caused nausea and vomiting; and diarrhœal and dysenteric troubles were stated to be unusually frequent. But no cases of malaria were reported as having originated in any part of the town. Several large ponds between Palmer, Massachusetts, and Union, have been completely drawn down and had their beds exposed, without any cases of malaria being known to have originated in the region.

Pigs as Wine-Bibbers.—Mr. W. Mattieu Williams says that he once witnessed a display of drunkenness among three hundred pigs, which had been given a barrel of spoiled elderberry-wine all at once with their swill. "Their behavior was intensely human, exhibiting all the usual manifestations of jolly good-fellowship, including that advanced stage where a group were rolling over each other and grunting affectionately in tones that were distinctly expressive of swearing good-fellowship all around. Their reeling and staggering, and the expression of their features, all indicated that alcohol had the same effect on pigs as on men; that under its influence both stood precisely on the same zoölogical level." He quotes also MM. Dujardin-Beaumetz and Audigé's account to the French Academy of Sciences of their experiments during three years on the effects of alcoholic diet on pigs. "Eighteen of these animals were treated sumptuously, according to old-fashioned notions of hospitality, by mixing various alcohols with their food, in proportions about corresponding to a modest half-pint of wine at dinner. The alcohols that we drink in wine, malt-liquors, whisky, hollands, brandy, etc., invariably produced sleep, prostration, and general lassitude, while absinthe (included as another variety of alcohol) produced an excitation resembling epilepsy. Some of the animals died from the effects of alcoholic poison. The survivors were killed, and subjected to *post-mortem* examination. All were found to be injured, but the mischief was greatest when crude spirit was used, less when it was carefully redistilled and purified.

Food-Fishes of Lake Erie.—In a paper read before the Buffalo Naturalists' Field Club it is stated that Lake Erie and the Niagara River furnish thirty-seven marketable varieties of fish. But their numbers are becoming rapidly reduced in those waters, owing in great measure to so many fish being taken when they are full of roe. Some fish spawn late in the fall; the eastern salmon, salmon-trout, whitefish, brook-trout, and lake-herring, belong to this class, but the majority spawn in April, May, or early June. Black bass choose a place for their spawn-beds where the water is shallow and the bottom is a sandy gravel. They leave their winter quarters in deep water a month or six weeks previous to spawning. The eggs hatch in from one to two weeks, according to the temperature. Bass are very prolific, yielding fully one fourth their weight of spawn. The bass and the muskallonge (*Esox nobilior*) are the recognized game-fish of the lakes. Whitefish do not take the bait readily, but are caught in gill-nets, and can be taken in great numbers

just at the time they are ready to spawn. They average three and a half pounds in weight, though some are taken weighing ten to eighteen pounds. Sturgeon average fifty pounds, but occasionally one is caught that weighs a hundred pounds or over. Fish differ greatly in rapidity of growth. Some grow in one, two, or three years to a definite size, and then growth seems to be arrested. Such fish are short-lived. Other kinds, which slowly and steadily increase in size, attain a great age. Pike have been known to be over a hundred years old. There is some confusion as to the names pike and pickerel. In England, where there is but one species of *Esox*, a young pike is called a pickerel. The pike of our Great Lakes is the true pike (*E. lucius*). The pickerel (*E. reticulatus*) is more common in small lakes and ponds. An easy way to distinguish them is to look at the gill-covers. If they are entirely covered with scales, it is a pickerel; but, if the lower half of the opercula is bare of scales, it is a pike.

Karen Funeral-Weddings.—Among the Shan Karens of Farther India, funerals are made the occasions of grand wedding festivals, in which all the marriageable young men and women of the village are prvileged to participate. As it is not always convenient to hold these interesting ceremonies at the exact time when a villager may die, it is customary to deposit the corpse of the deceased in some temporary resting-place, or to burn it and preserve the ashes till the times and the marriage-market are more favorable to giving it obsequies worthy of its former estate. Consequently, six months, or a year, or more, may frequently pass before the memory of the dead Karen receives the honor which is its due. When a good time for weddings comes, the remains are taken from their temporary resting-place and set upon a platform or mat which has been prepared for them, and the eligible bachelors and marriageable young women of the neighborhood having been invited to come and compete in a marrying-match, arrange themselves, dressed in their gayest, in two choirs on opposite sides of them. The "funeral service" is then begun with a chorus of the men celebrating the beauties of the Karen maidens in general. The girls respond in their drawling falsetto, "calmly accepting the eulogy of their graces." These overtures are usually set pieces, handed down from antiquity, or taken and translated from some popular Burmese play. Next, the bachelors, each in his turn, beginning usually, for the sake of peace, with the most muscular one, "deliver themselves of love-stricken solos," directed by name to the several damsels whom they have chosen; if one of them is rejected, he waits till his turn comes again, and addresses, if he sees fit, some other girl. The girls receive the proposals in perfect self-possession, and respond to them in phrases like those with which they have been addressed, the models of which have come down from the old times. All the praise the maiden has received, she appropriates as only her just due, and continuing, she declares that it is a shameful thing not to be married, but that it is worse to be divorced afterward, "to be like a dress that has been washed," but that she will do what she is bid. If the girl rejects the address, she may do so in a tone indicating that she does not consider she has been praised enough, or with some such indirect phrase as "Come to me when the full moon appears on the first day of the month; come dressed in clothes that have never been stitched. Dress and come before you wake. Eat your rice before it is cooked, and come before daylight." Rejections, however, seldom occur, except when some young man makes a mistake and applies to a girl who is known to be reserving herself for another. The "funeral service" goes on in this way till it is plain that no more alliances can be made, when it is closed, all the crockery that belonged to the deceased is broken, and the body is permanently buried. The matches thus made are binding, and no other way of making them is in favor; and, if any preliminary private courting takes place, it is subsidiary to the funereal occasion.

Steel-Iron.—Professor M. Keil has produced a composite material of iron and steel in which the valuable qualities of the two substances are combined, and the combination is made available for a variety of uses. The principle of his process is ex-

emplified in a cast-iron mold divided centrally by a thin sheet of iron, on one side of which sheet fluid iron is poured, and on the other side fluid steel. The dividing plate should be thick enough to prevent the glowing masses on either side from burning through it, and yet so thin that those masses and it shall become thoroughly welded together. The combination has been produced in five shapes: steel by the side of iron; steel between two layers of iron; iron between two layers of steel; a core of steel with the surrounding shell of iron; and a core of iron with the surrounding shell of steel. This steel-iron may be used for a great variety of purposes in which the hard qualities of steel, enabling it to resist wear and tear, or adapting it to cutting purposes, need to be backed by a tougher material competent to resist strains and great vibration.

Hedgehogs and their History.—Professor Grant Allen, writing in an English paper of the structure and habits of the hedgehog, observes that the curious spines the animal wears on his back are a feature very apt to recur among animals of different classes the world over, which are much exposed to carnivorous enemies. The porcupine, a rodent in no way related to the hedgehog, and the Australian echidna, allied to the ornithorhynchus, have precisely similar spines. "The fact is, almost all surviving members of very low and early groups are extremely likely to have such peculiar spiny or armor-plated bodies, because only those which happened to be so protected have managed to escape the persistent attention of a million generations of vermin-eating carnivores. Hence they are apt to be either prickly, as in these instances, or else protected by a regular covering of bone-like hardness, as in the armadillo, the poyou, the pangolin, and the scaly ant-eaters. The spines of the hedgehog are in reality very hard, bristly hairs, specially developed for purposes of defense. Of course, however, he did not get these most effective *chevaux-de-frise* all at a single blow. They are the result of slow and constant modification in a long line of ancestors, and not a few intermediate forms are still in existence to show us, either directly or by analogy, the fashion in which the defensive prickles were originally evolved. The bulau, of Sumatra, has a few stout bristly hairs scattered among the fur of its back, and gives the first indication of a tendency toward the production of spines. It can not, however, roll itself up into a ball, like the hedgehog. The tanrec, of Madagascar, is covered with a mixture of hairs, bristles, and true spines; while another animal of the same island still more closely approaches the hedgehog in the greater spininess of its body and in the possession of the power of rolling itself up. "Finally, we get in Europe and Asia several kinds of genuine, fully developed hedgehogs, of which our own English specimen here in the ditch is a typical example. It is not often that all the intermediate stages between two distinct animal types have been so well preserved for us by nature as in this interesting instance."

Science in Brazil.—M. de Quatrefages recently improved the occasion of presenting to the French Academy of Sciences a number of documents from the Brazilian museum at Rio Janeiro, to speak in praise of the scientific progress that has been made in that country under the wise encouragement of the Emperor Dom Pedro II. The government, societies, municipalities, and a host of individuals, are rivaling one another in their zeal for the multiplication of educational establishments and for endowing them as richly as possible. Nearly one sixth of the revenue of the country is applied to purposes of public instruction. The first four volumes of the archives of the National Museum are marked by many valuable essays, among which were spoken of, as particularly deserving attention, the studies of Dr. Pizzarro on a curious batrachian, and of M. Frederick Muller on insects; of M. Lacerda on the poison of different snakes and of a toad; the anthropological labors of MM. Lacerta and Peixoto on the tribe of the Botocudos, and on some skulls found in ancient funeral urns; and a memoir by M. Ladislau Netto regarding American origins and migrations. The last study is based upon the strange custom, which is observed in a large number of tribes from the extreme northwestern part of the continent to Brazil, of boring the

lower lip and hanging from it ornaments of different forms and natures. A paper also appears in this volume by M. Fireira Penna on the *ceramios* of Para, low tumuli, which are wholly composed of urns or other vessels of terra-cotta, laid together and arranged in beds. The recent Brazilian Anthropological Exhibition, which was very successful, is to be followed by another, in which it is hoped the whole American Continent will be represented.

Magnetism of a Great City.—Mr. Richard Jeffries, in his essays on "Nature near London," remarks upon the way in which the magnetism of London is a force in its remotest suburbs, and the influence of the mighty city is felt in its most rural environments. "In the shadiest lane," he says, "in the still pine-woods, on the hills of purple heath, after brief contemplation there arose a restlessness, a feeling that it was essential to be moving. In no grassy mead was there a nook where I could stretch myself in slumberous ease and watch the swallows ever wheeling, wheeling in the sky. The something wanting in the fields was the absolute quiet, peace, and rest which dwell in the meadows, and under the trees, and on the hill-tops in the country." The inevitable end of every foot-path round about London is London; the proximity of the immense city induces a mental, a nerve restlessness; and, as you sit and dream, you can not dream for long, for something plucks at the mind with constant reminder "that the inland hills, and meads, and valleys, are like Sindbad's ocean, but that London is like the magnetic mountain which draws all ships to it."

Bacteria and Cholera.—Dr. Koch, of the German Cholera Commission, has made a report of the commission's examinations of cholera cases in Egypt. The disease was on the decline when the commission began its work, and this may partly account for the unsatisfactory character of the results. Twelve unquestionable cholera patients were examined, and autopsies were held on the bodies of ten persons who had died of cholera. No micro-organisms were found in the blood of the patients, and but few in the matters vomited up, but a considerable number were found in the dejections. In the autopsies, no infectious organic matter, except a few probably accidental bacteria in the lungs, was noticed in the lungs, the spleen, the kidneys, or the liver. A well-determined species of bacteria was, however, found in the walls of the intestines, and in some cases had penetrated to the tubular glands of the mucous coat, and provoked an irritation there, and had even reached the deeper layers of the mucous coat, and sometimes the muscular coat. It seemed evident that they had a connection with cholera, but whether as cause or merely as an accompaniment or result was still uncertain. To test this question, inoculations were made upon mice and monkeys, and a few dogs and chickens, and the bacterial poison was administered to some of the animals, but without effect in producing symptoms of cholera; although in a few of the cases septic affections followed. The results actually obtained, however, seem to Dr. Koch to afford a good reason why the experiments should be continued.

Superstitions about Infants.—Dr. H. Ploss remarks, in his book (in German) on "The Child in the Customs and Usages of Peoples," that the birth of a child impresses its relatives with the feeling that they are brought into the immediate presence of one of the mysterious powers of Nature, whose kindness in conferring the gift is acknowledged, and whose favor is invoked with observances in which feasts and offerings nearly always have a place; and the ceremonies observed on such occasions, and the toys that are given the child, have frequently an ingenious, sometimes an educational significance. The natural process of birth is brought, in the imagination of the people, into relation with hidden or supernatural causes: by many tribes it is supposed to be superintended by particular divinities; and the dangers and diseases to which the child is subject are ascribed to similar mysterious agencies. The accidents of pregnancy, the cries and calls, the influence of the evil-eye, the substitution of a changeling for the child, the ill-omened significance attached to certain acts, form a stock of superstitions deeply impressed in the popular imagina-

tion. From the search for supernatural means of driving away the evil spirits supposed to be working harm to the child have arisen very curious and wide-spread doctrines which are of great value in the history of customs. The little being who has come into the world is not always believed to be pure, and to have a clear right to existence. Many peoples regard it as "unclean" and not to be touched for a certain time. Others require it to be expressly recognized by the father; and some give the parents a right to expose or kill it immediately. Among most people it is considered essential to perform some kind of ceremony for formally adopting the child into the family and society. Such ceremonies are generally dietetic, or relate to washing and bathing, anointing the skin, giving the first food, circumcision, putting on clothing, or cutting the hair, and are observed as important mysteries favorable to bodily endurance and mental vigor. Here we approach the transition from the instinctive hygiene of popular customs to religious ceremonies. Survivals of the notions here pointed to are traced by Herr Ploss among popular customs that have not yet died out in the more retired districts of Europe.

Use of Salt.—Among other follies of the day, some indiscreet persons are objecting to the use of salt, and propose to do without it. Nothing could be more absurd. Common salt is the most widely-distributed substance in the body; it exists in every fluid and in every solid; and not only is it everywhere present, but in almost every part it constitutes the largest portion of the ash when any tissue is burned. In particular, it is a constant constituent of the blood, and it maintains in it a proportion that is almost wholly independent of the quantity that is consumed with the food. The blood will take up so much and no more, however much we may take with our food; and, on the other hand, if none be given, the blood parts with its natural quantity slowly and unwillingly. Under ordinary circumstances, a healthy man loses daily about twelve grains by one channel or the other, and, if he is to maintain his health, that quantity must be introduced. Common salt is of immense importance in the processes ministering to the nutrition of the body, for not only is it the chief salt in the gastric juice, and essential for the formation of bile, and may hence be reasonably regarded as of high value in digestion, but it is an important agent in promoting the processes of diffusion, and therefore of absorption. Direct experiment has shown that it promotes the decomposition of albumen in the body, acting, probably, by increasing the activity of the transmission of fluids from cell to cell. Nothing can demonstrate its value better than the fact that, if albumen without salt is introduced into the intestine of an animal, no portion of it is absorbed, while it all quickly disappears if salt be added. If any further evidence were required, it would be found in the powerful instinct which impels animals to obtain salt. Buffaloes will travel for miles to reach a "salt-lick"; and the value of salt in improving the nutrition and the aspect of horses aud cattle is well known to every farmer. The popular notion that the use of salt prevents the development of worms in the intestine has a foundation in fact, for salt is fatal to the small thread-worms, and prevents their reproduction by improving the general tone and the character of the secretions of the alimentary canal. The conclusion, therefore, is obvious that salt, being wholesome, and indeed necessary, should be taken in moderate quantities, and that abstention from it is likely to be injurious.—*Lancet.*

Intelligence of a Turret-Spider.—The nest of the *Tarentula arenicola*, or American turret-spider, is a vertical tube, extending twelve or more inches into the ground, and projecting half an inch to an inch above the surface. The projecting portion, or turret, is in the form of a pentagon, more or less regular, and is built up of bits of grass and straw, small twigs, etc., cemented with mud, like a miniature old-fashioned chimney. The upper part of the tube has a thin lining of web-silk. A nest was exhibited by Vice-President H. C. McCook, D. D., at a meeting of the Academy of Natural Sciences, of Philadelphia, which, during its journey from Vineland, New Jersey, where it was found, had been plugged at top and bottom with cotton. Upon the arrival of the nest in Philadelphia, the plug guarding the en-

trance had been removed, but the other had been forgotten. The spider, which still inhabited the tube, immediately began removing the cotton from the lower end, and cast some of it out. But guided, apparently by its sense of touch, to the knowledge that the soft fibers would be an excellent material with which to line its tube, it speedily put in a cotton padding for about four inches downward from the opening. Dr. McCook pointed out the very manifest inference that the spider must, for the first time, have come in contact with such a material as cotton, and had immediately utilized its new experience by adding the soft fiber to the ordinary silken lining.

NOTES.

THE Franklin Institute will open an International Exhibition of Electricity and Electrical Appliances in Philadelphia, on the 2d day of September next. By a special act of Congress, all articles "imported solely for exhibition" on this occasion will be admitted free of duty; but, if they are sold or withdrawn for consumption, the regular duties must be paid upon them.

VICTOR-ALEXANDRE PUISEUX, a French astronomer, died in September last. He was the author of numerous memoirs on astronomical subjects to the Academy of Sciences, and had been occupied very industriously with calculations based upon the transits of Venus of 1874 and 1882.

DR. J. B. SUTTON, of Middlesex Hospital, in a communication to the "Lancet," disproves the current opinion that monkeys die chiefly from tubercle. Having been permitted to attend the *post-mortem* examinations of animals dying in the Zoölogical Gardens, Regent's Park, he personally inspected the remains of ninety-three monkeys. Of this number, three were found to have died of tubercle, twenty-two of bronchitis, three of lobar pneumonia, seven of lobular pneumonia, one of septic pneumonia, twenty-three of other diseases, including three of scrofula and four of typhoid fever, while in thirty-four cases no lesion was met with sufficient to explain the deaths of the creatures.

DR. CONRAD BURSIAN, a distinguished German philologist, died on the 21st of September, having just a few days before finished his great work on the "History of Philology." He had been a professor successively in the Universities of Leipsic, Tübingen, Zurich, and Munich, and was a member of several learned societies.

M. CHEVREUL, the "dean" of the French Academy of Sciences, reached his ninety-eighth year on the last day of August, and was still physically vigorous and fresh of heart. The President of the Academy, in taking notice of the fact, remarked: "M. Chevreul has belonged to the Academy which he has so much honored by his labors for fifty-seven years; and he would, in fact, have counted it sixty-seven years, if by an extremely rare sentiment of generosity he had not allowed himself to be passed over in 1816, to give place to a chemist (M. Proust) whom he called his master."

STATISTICIANS have pronounced the United States to be not only potentially but actually richer than the United Kingdom. Counting the houses, furniture, manufactures, railways, shipping, bullion, lands, cattle, crops, investments, and roads, it is estimated that there is a grand total in the United States of $49,770,000,000. Great Britain is credited with something less than $40,000,000,000, or nearly $10,000,000,000 less than the United States. The wealth per inhabitant in Great Britain is estimated at $1,160, and in the United States at $995. With regard to the remuneration of labor, assuming the produce of labor to be 100, in Great Britain 56 parts go to the laborer, 21 to capital, and 23 to government. In France 41 parts go to labor, 36 to capital, and 23 to government. In the United States 72 parts go to labor, 23 to capital, and five to government.—*London Times.*

M. JOSEPH-ANTOINE-FERDINAND PLATEAU, an eminent physicist and emeritus professor at the University of Ghent, died September 15th, in his eighty-second year.

M. A. MILNE-EDWARDS reports that he met with great success near Teneriffe on his deep-sea expedition in the steamer Talisman. The dredging apparatus is strong enough to bring up rocks weighing a hundred kilogrammes from the depth of a thousand metres. The collections promise to be immense, greater than it will be possible to bring home. Among the species gathered are crustaceans of forms resembling those of the Antilles, curious fishes with luminous organs, crinoids, asterias, strange holuthurians, numerous sponges, and molluska, exhibiting a novel mingling of African with Mediterranean and Polar forms. On the Island of Branco, which had never been scientifically visited before, the expedition found large lizards, such as are not known to occur anywhere else, and which appear to have a good living of herbaceous food, although the island is nearly destitute of vegetation.

DR. J. LAWRENCE SMITH, of Louisville, Kentucky, died on the 12th of October last, in the sixty-fifth year of his age. He had dis-

tinguished himself by many valuable chemical researches and publications respecting them, particularly by his investigations into the composition and nature of meteoric stones. A portrait and sketch of Dr. Smith were given in "The Popular Science Monthly" for December, 1874.

MR. MORGAN J. ROBERTS tells in "Nature" of a collie-dog owned by him which was accustomed to go with him fishing, and took great interest in the business. She learned that there existed a close connection between the bobbing and final disappearance of the float and the pulling up of a fish, and would become very much excited whenever she saw the float in agitation. On one occasion when her master was away from the rods, observing a float disappearing, she uttered one or two sharp yelps, and, her master failing to come, herself seized the rod, and, "backing" with it, attempted to pull the line from the water. The hook held "a goodly eel."

PROFESSOR OSWALD HEER, the distinguished Swiss paleontologist and botanist, died at Lausanne, September 27th. He was director of the Botanical Garden at Zurich, and editor of the Swiss "Journal of Agriculture and Horticulture"; and was the author of the "Urwelt der Schweitz" ("Primitive World of Switzerland"), which has been translated into many foreign languages; of a work on Swiss *Coleoptera;* and, in connection with Hegetschweiler, of the "Flora of Switzerland."

MILLEMAINE is the name of a new cereal which has been introduced into South Carolina, from Colombia, South America. It is allied to sorghum and Guinea corn, and has the merit of an almost unlimited capacity to endure drought. Cakes made from the meal have been described as better than corn-cakes, and the grain has been pronounced by the chemist of the Savannah Guano Company superior in food qualities to wheat.

M. ALFRED NIAUDET, who died in October last, is pronounced by "La Nature" to have been the person who, more than any other one, contributed to the development in France of the industries dependent on electricity. He did valuable service to the country in his special line during the Franco-Prussian War, and, besides numerous papers on dynamo-electric machines, telephony, and telegraphy, was the author of two works that are authorities on electric piles and dynamo-electric motors.

THE death is reported of M. F. S. Cloëz, an industrious French chemist, who assisted M. Chevreul some thirty-six years ago, and was afterward Professor of Physics in the School of the Fine Arts. He was author of several memoirs of considerable value.

ACCORDING to Dr. Sach, of Buenos Ayres, there is no danger of an exhaustion of the quinine-supply. The experimental plantations in Java and the Island of Réunion have been very successful; and, besides these nurseries, the trees have been cultivated in Bolivia by the million for ten years. At three places in the last-named country, taken as they come, the number of trees growing is given, severally, at 70,000, 200,000, and 3,500,000.

DR. CHARLES WILLIAM SIEMENS, the distinguished engineer and electrician, died in London, November 20th, of rupture of the heart. He was born in Lenthe, Hanover, in 1823, and has given the world the regenerative gas-furnace, with an improved process for making steel; has been greatly instrumental in the extension of telegraphic cables, and has produced a series of valuable improvements in the saving and utilization of heat and in applications of electricity.

M. JULES CARRET has found, by comparing the statistics of conscripts furnished from a certain region of France during ten years of the first empire with those for 1872–'79, that in every commune an increase is apparent in the average height of the inhabitants. If this is established, the fact will tend to contradict Broca's view that stature is almost wholly a matter of ethnic heredity, and to show that improvement in the conditions of life has something to do with it.

WITH the death of M. Louis Breguet, which took place suddenly on the 27th of October, is "effaced for the moment," says M. Blanchard, President of the French Academy of Sciences, "a name celebrated in the mechanic arts from the eighteenth century." He was the grandson and business successor of Abraham Breguet, who founded the watch-making house of that name in 1780, and was the father of the late Antoine Breguet, of the "Revue Scientifique." He was himself distinguished for services in the applications of electricity and in the advancement of telegraphy, and was a member of several learned societies. He was sixty-nine years old.

A WAY has been found for utilizing the bodies of animals that have died of anthrax. They are treated with sulphuric acid, and then converted into superphosphates. The germs are destroyed during the process.

DR. JOHN L. LE CONTE, one of the most eminent American entomologists, died at his home in Philadelphia, November 15th. He presided at the Hartford meeting of the American Association in 1874. A portrait and sketch of him were given in "The Popular Science Monthly" for September, 1874.

STUDENTS' CHRISTIAN ASSOCIATION
JAN
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1884

CHARLES WILLIAM SIEMENS.